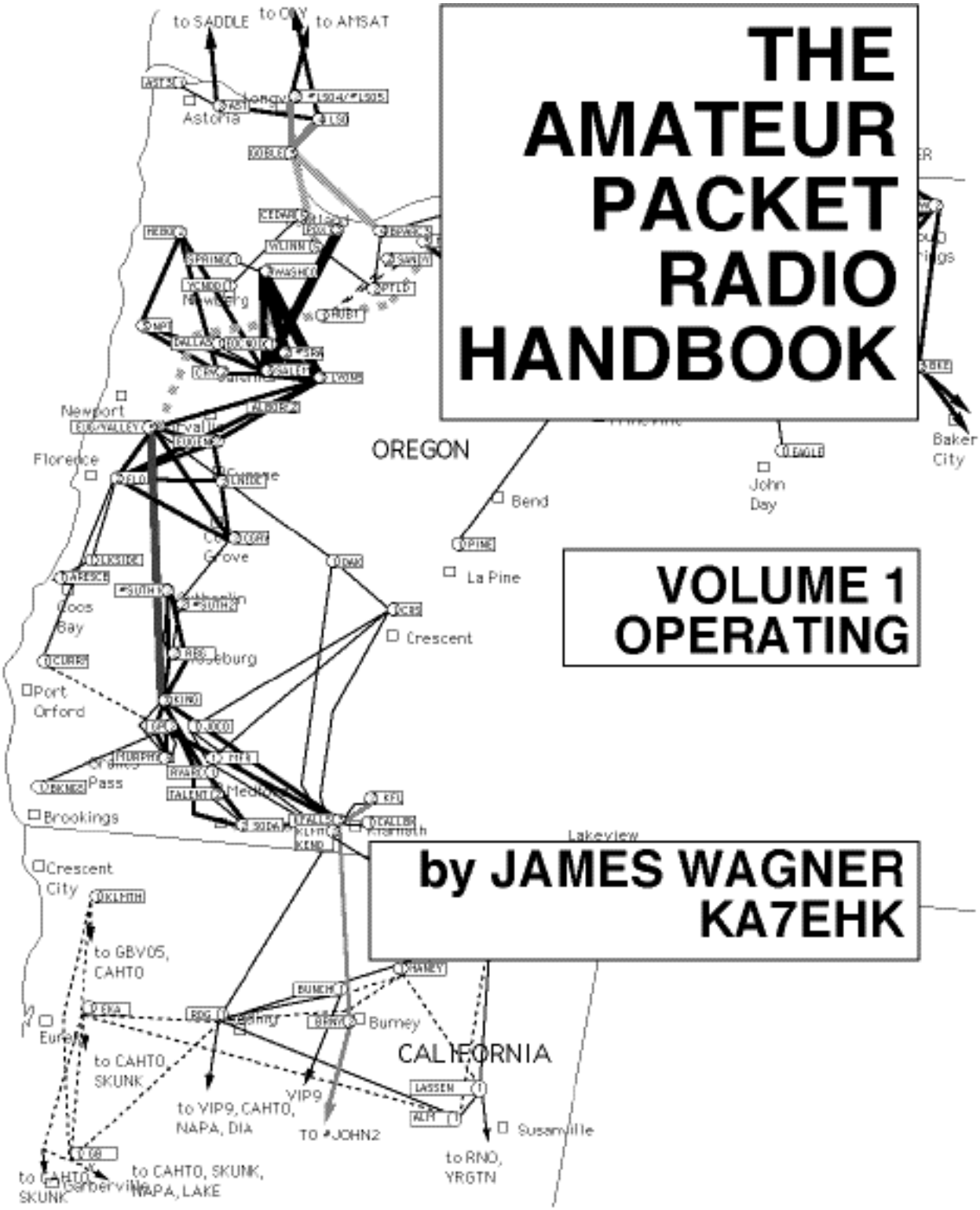

THE AMATEUR PACKET RADIO HANDBOOK

VOLUME 1 OPERATING

by JAMES WAGNER KA7EHK

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Chapter 1 WHAT IS PACKET RADIO?

Packet radio is one of the newer modes of communication available to hams. It is also a mode with very rapid growth. Much of this growth is with new no-code hams who have had relatively little experience with ham radio. This chapter is intended for those of you who are just starting, or thinking of starting, with packet.

1.A WHAT IT IS

Digital methods of communication have been around since the very start of radio. CW (ie, Morse code) is really digital. The transmitter is switched on and off to convey information. In this mode, the relative duration of the on times and off times carries the information.

Voice varies some characteristic of a transmitter in proportion to the strength of the electrical signal coming from a microphone. The characteristic can be amplitude; this results in AM (amplitude modulated) or SSB (single side-band) transmissions. The characteristic can be frequency which results in FM (frequency modulated) transmissions.

After World War II, military and civilian teletype machines became available to hams. They were adapted to radio use and the result is RTTY (Radio TeleTYpe, often spoken as "ritty"). This is also a digital mode, but quite different from CW. This style of operation keeps the transmitter operating continuously rather than on-and-off. One mode sends a tone (rather like a voice signal but a single frequency). The data is carried by switching the tone frequency (ie, pitch) back and forth between two specific values. This is called audio frequency shift keying or AFSK. The other mode shifts the transmitter frequency back and forth between two values. This is called frequency shift keying or FSK. RTTY works fairly well... except that it is not a very efficient use of our limited frequencies, and it works more and more poorly as conditions become crowded.

Packet radio is one of several "modern" extensions of RTTY. Depending

on the operating frequency, packet may send much more rapidly than RTTY. It also has error correcting which RTTY does not. Packet is not the only such mode: AMTOR is another and CLOVER is a third. Both of these are considered "better" for use on lower frequencies and packet "better" for VHF. Packet may use FSK or AFSK; on VHF at standard character speeds, AFSK is commonly used.

Packet uses a protocol called AX.25. A protocol is a set of rules. In this case, the set of rules tells how characters a bundled together into a collection called a packet. It also tells how stations connect with each other and how errors are handled (see Chapter 10 for more information).

Thus, packet is a technique for sending and receiving characters. These characters usually represent typed text. But packet is not limited to straight text since any computer file such as a program is also represented by a set of characters.

1.B WHAT HAMS TO WITH PACKET RADIO

Packet radio is used for a great variety of things. The first which comes to mind is the hallowed QSO, the face-to-face, or in this case, keyboard-to-keyboard, conversation. QSOs are a big part of packet, also. But, percentage-wise, it makes up a smaller fraction of activity than most other modes.

So, what is the rest of the activity? Much of the message passing is through the medium of the bulletin board (BBS). This is basically like letter writing! Often, messages are left in the mailbox contained within a specific station's modem. Other times, messages are in independent bulletin boards. These are able to transfer messages from one BBS to another, automatically.

Many hams immediately think of emergency communications when they learn about packet radio. Indeed, under some circumstances, it works very well (see section 1.C).

Some of the other ham activities, such as DX, are more difficult. HF bands are preferred. Packet on HF takes a good deal of skill.

Many hams use packet in conjunction with other ham activities. One of the major ones is "DX spotting". In this case, packet is used as a method

for DX operators to notify each other when new DX stations appear on HF.

Traffic handling is another traditional ham activity and packet is useful here, also. It is particularly suitable with complex messages; the error correcting can improve accuracy. Traffic handling on packet is particularly useful in emergency situations where large amounts of "health-and-welfare" traffic are involved.

1.C WHAT IT WORKS WELL FOR

With the preceding summary of ways in which packet is used, it might seem to be a "universal" solution to amateur communications. Nothing could be further from the truth.

Packet is not very efficient on HF. AMTOR and CLOVER are usually superior in terms of frequency use and achieved character rate. This is a measure of how rapidly characters get delivered at the receiving end. It takes into account the error rate and everything which must be done to fix the errors. Packet is usually the preferred mode on VHF using FM. On VHF, tones are usually used, so it is FM-AFSK. At higher baud rates, true FSK is commonly used.

In emergency communications, packet does not work very well for tactical communications. This includes things such as base-camp to search-crew communications. Where it does work, and work very well, is strategic communications. This sort of work usually involves lists: "Avenue-A shelter needs 23 cots, 47 personal meal packs, ...". Packet insures accuracy in such situations. Incoming health-and-welfare messages trying to locate displaced individuals is another effective emergency use. Such messages can easily be circulated among shelters or other sites. Likewise, lengthy detailed reports from county emergency centers to regional or state centers are often handled by packet.

DX spotting also works well. These DX Clusters or DX Spotting Systems are widely distributed. In areas with substantial population density, several of these are often linked together.

Traditional QSOs are not as easy as one might like. This is especially true over long distances. Even though there is a network linking widely separated points, it does not always work that well for simple conversations.

BBS "mail" can work well or poorly, depending on local conditions. It may take only a few hours to move a message from coast to coast. But it may take that long or longer to move messages through a major metropolitan area.

From this discussion, it should be apparent that there are lots of interesting things to look for in packet. And just because something "works poorly" is not a reason to give up on it. This is an area where change is frequent. Ideas for improvement can make a difference. And, you need not be a computer professional to have fun!

The Amateur Packet Radio Handbook Chapter 2
Copyright James Wagner, 1993 EQUIPMENT

There are three basic pieces of equipment which are needed to operate packet. These pieces are (broadly): (1) a radio and the support stuff needed to make it work, (2) a modem, and (3) a terminal.

2.A TERMINALS

A terminal is a device you type on to send messages. It also displays messages which come to you. Terminals come in many forms (and prices).

2.A.1 DUMB TERMINALS: In principle, almost any terminal can be used with a packet modem. Many who do not already have a computer look at dumb terminals or glass teletypes because they can be very inexpensive. So long as they are RS232 ASCII devices, they will work. But using one puts you at a real disadvantage. Once the text has left the screen, it is lost, forever. These devices very rarely have the ability to save incoming text. On the other hand, if your goal is to do packet at an absolute minimum cost, you might find this attractive. If this is the case, do not overlook some of the alternatives mentioned below.

2.A.2 OLDER COMPUTERS: Many older computers can be quite inexpensive and attractive so long as suitable software is available. A few still use Apple IIs (though software is scarce). Commodores, (especially C64s) are quite often used; several modem manufacturers provide software for C64s. You must be careful about using C64s because the serial input/output is "TTL" rather than RS232; either a special adaptor or a modem which accepts TTL is needed. Potential C64 buyers are well advised to avoid "C64+4" machines. These are not compatible with standard C64s and software in nearly nonexistent. TI-99, Commodor VIC-20 & PET, and Apple Lisa computers are also to be avoided.

Older 8086-based IBM-style PCs are available for a few hundred dollars or less. This will not get you a hard-disk or color monitor but you really do not need either of these. You do need at least one RS232 serial port. The '186 and '286 computers are also good but may cost a little more.

2.A.3 MODERN COMPUTERS: Newer computers of all kinds are acceptable. These include '386 & '486 PCs, Macintoshs, and UNIX workstations. There is a variety of software available although seldom written specifically for packet operation. Many people (including the author) have never used packet-specific software and are able to make the packet system do everything for them which anybody else can do. Laptops work well for mobile and portable packet. Palmtops can often work although the key size can make typing difficult. Some data organizers will also work but check very carefully before purchasing one.

See Chapter 18 in Volume 2 for discussion of packet terminal software.

2.B MODEMS

There are several types of modems in common use. But before discussing modems, lets look at what they need to do. Usually, in packet radio, the modem is responsible for managing the message construction, connection, error correction, and mailboxes, to name just a few functions. The modem must also carry out the conventional modem tasks of converting logic signals into a form suitable for radio transmission. To do this, the modem has two parts. One is the classic modem (which, at lower baud rates, uses audio tones). The second part is really a specialized computer which carries out the packet-specific functions.

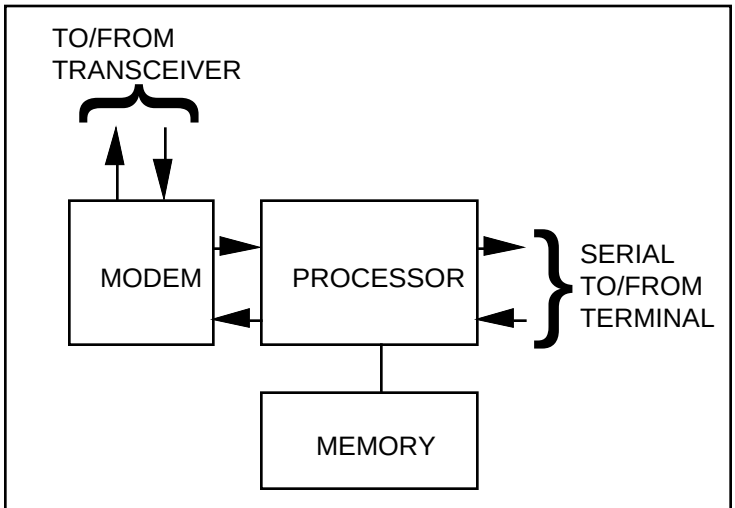

FIGURE 2-1, TNC BLOCK DIAGRAM

To be fair, it should be noted that there are situations in which a computer carries out the packet-specific functions and a true (and simple) modem is used. Several of these are actually quite popular because of very low cost (see DigiCom and BayCom, below).

2.B.1 TNC2's: Of the conventional packet modems, a very common type is the TNC2 clone which is made by several manufacturers. The term TNC stands for terminal node controller. These include the MFJ-1270 and MFJ-1274. There are several made by other manufacturers which are functionally quite similar to the TNC2 types but have different (but similar) commands and capabilities. These include the AEA PK-232s & PK-232MBXs, and Kantronics KPC3s.

2.B.2: MULTIMODE CONTROLLERS: These handle modes such as AMTOR and RTTY in addition to packet. These are of little use unless you plan to operate on HF.

2.B.3: BayCom MODEMS: The BayCom modem is a true modem which relies on an IBM-style computer to carry out the packet related functions. It requires special software to make it operate.

2.B.4: DigiCom MODEMS: Similar to BayCom but specifically for Commodore C64 computers.

2.B.5: THE DATA ENGINE is a relatively new device which is targeted specifically at high speed operation. It can operate with two radios and is particularly well suited for use with bulletin boards and nodes.

2.B.6: CROSS-BAND TNC's: Kantronics makes some specialized TNCs which are particularly designed to operate simultaneously on one HF frequency and one VHF frequency. The form of operation is often referred to as a KaNode. They are frequently available for use by others.

2.B.7: EXPANSION-SLOT PACKET MODEM: These are cards which plug directly into expansion slots in computers (usually PC/clone). Some may act, as far as computer software is concerned, as a serial card.

2.B.8: MODEM-COMPUTER CONNECTION: Along with the modem, you need a cable to connect the modem to your terminal. Most TNCs appear to provide a DB-25 female connector. The other end must match

your terminal, whether it is DB-25, DB-9, DIN, or other. Many TNC manufacturers make available cables for specific computers (usually at extra cost).

A list of packet modems and their manufacturers is included in Chapter 19 of Volume 2.

2.C A NOTE ABOUT MODEM COMMANDS

Not all TNCs use exactly the same commands. The commands which are used in this book are generally the TNC2-clone commands. Where alternative commands are known, they are indicated. In general, a name or description is used with the command. If you look up in your instruction manual using the the descriptive words used here, you should come close. If you do have problems, feel free to contact the author.

2.D RADIOS

Most hams come to packet radio with a radio they use for other purposes. It is a very rare situation where we have the luxury of selecting something specifically for packet. As a result, the most commonly used radios are hand-talkies or mobile radios. But if we know a little about what makes a radio good for packet, better choices can be made when the time comes to get that new(er) radio.

2.D.1: RADIO CHARACTERISTICS: Transmit/ Receive (T/R) switching is a significant factor. Many older radios use mechanical relays for switching. These relays are both slow and rapid to wear out. One of the aspects of packet as compared to voice is the much more frequent change from receive to transmit. Thus, relays tend to fail more quickly. The slow switching time adds to transmitter keyup time. The consequences of this are discussed in section 2.F.

Many of the older synthesized radios take some time to settle in frequency (even in simplex operation) when changing between receive and transmit. This may cause the start of the packet of other stations to be missed, for example. Here, the best advice is experience of other packet operators.

2.D.2: MODEM-RADIO CONNECTION: One of the long standing problems in assembling a packet radio station is connecting the modem to a radio. There is usually some information in the instructions with the

TNC. If the radio is fairly new, there may also be information in its instructions.

Many TNCs, perhaps most, come with a radio cable. When it is supplied, it almost always comes without connectors on the radio end. It is your problem to make that final link. To make the connection, you must determine one crucial piece of information about the radio: how does the transmitter key? To determine this, you need to look at the audio connector(s). If the connector is a multi-pin circular connector (commonly used for speaker-microphones or microphones with telephone keypads or microphones with radio control buttons) determine whether one of the pins is a PTT (push-to-talk) function. If so, the transmitter keying is separate from audio. If the only connector(s) are miniature audio jacks (common on handi-talkies), inspect the microphone jack. If the jack takes a 2-circuit plug (like a stereo plug), then transmitter keying might be separate from audio. If the transmitter keying is not separate from audio, then it is combined with audio (and almost always with transmit audio).

With many TNC's an internal jumper must be added for combined PTT and transmit audio. With others, the PTT and transmit signals must be combined as part of the wiring between the TNC and the radio; in this case it may be necessary to connect transmit audio throught a capacitor and PTT through a resistor to a single terminal of the radio. Check your both radio and TNC instructions for the information about how to do this. If you have purchased your TNC used, verify that this jumper is appropriate for your transmitter.

2.D.3 ANTENNAS: It is not always obvious what antenna arrangement is "best" for packet radio. One general rule is that operation will be much better if you can locate an antenna away from your TNC and terminal. 10-20 feet (3-6 meters) will generally be sufficient unless your computer is particularly noisy.

One of the big arguments concerns non-directional vs directional antennas. Most of if this discussion will be postponed until section 2.E because you may not be able to tell until your station is in actual operation. At this point, it is worth mentioning that part of the choice is determined by the geographical pattern of stations (and nodes) in your area. If you will likely connect directly with stations in a variety of directions, then an non-directional antenna may be best. But if most of your work is likely to be in one direction, a beam may be better. You should not offend anybody if you start with an non-directional antenna.

2.E ASSEMBLING YOUR PACKET STATION

After gathering the basic pieces, there comes a time when you need to go ahead and "do it". This section will suggest a step-by-step process you may be able to use. This assumes that you are not using a TNC in KISS mode; if you want to do so, please try it simpler first! In the following, text you type is *ITALICIZED* .

2.E.1 SETTING UP A TNC & COMPUTER: Now, lets get specific about TNCs and computers.

SETTING UP THE MODEM

Step 1: Connect your terminal to the modem. Few cases require more than a 3-wire RS232 link. Again, see Chapter 20 (Volume 2) for suggestions.

Step 2: Connect the power source to the TNC. Most TNC's require 12V DC. This may come from a wall adaptor provided with the TNC or it may come from the transceiver power. Be VERY CAREFUL that power is connected in the correct polarity or you may destroy the TNC! Leave the power OFF at this point.

Step 3: Turn on the terminal. If it is a computer, start the terminal program. If the program is a conventional terminal emulator, then proceed. If it is a more elaborate program (such as LanLink, TCP/IP, etc) follow the program's instructions. Many of these require configuration files to begin. You may find it easier with a simple "terminal emulator" at the start (see Chapter 18, Volume 2).

Step 4: Configure the terminal serial parameters (except for BayCom or DigiCom). You need to read the TNC's instructions to determine the TNC's default serial parameters. It appears that TNC2 clones default to 1200 baud, even parity, and 7 bit data; you need to set your terminal to the same. You should also try "full duplex". Later, you will be able to find out if the latter choice is correct.

Step 5: Apply power to the TNC. (Ignore for BayCom) The power light, if there is one, should turn on. You should see on the terminal screen a "log-on message". This often gives the manufacturer's name,

the software version, and perhaps some memory information.

Step 6: (Ignore for BayCom or DigiCom) If no message is seen, try pressing the "enter key" several times. A few TNCs require some characters from the terminal to determine the baud rate. If you still do not see anything, retry the power several times. If you still do not see anything, try other combinations of parity and data bits. If you still do not see anything, make certain that the terminal serial output is connected to the modem serial input and that the terminal serial input is connected to the modem serial output.

Step 7: Send a "command mode character" to the TNC from the terminal. For default TNC2 clones, this is "control-C". Check in your TNC instructions for information if control-C (which will be abbreviated "^C" from now on) does not work. With a command mode character, you should see the command mode prompt on the screen. Again for TNC2 clones, this prompt is "cmd:". Once you get this, you are "half-way there".

Step 8: Program the TNC operating parameters. First and foremost is you callsign. For TNC2 clones, you type *MYCALL callsign* where "callsign" is your call. Nodes and other stations will not permit you to connect with the default call which is often "NOCALL" Some TNCs may require you to specify different callsigns for the mailbox and digipeating; see comments about "SSID" later on and check in your area for the standard practice concerning these assignments.

I do not change many of the defaults. What is particularly important at this point is TXDELAY (TNC2 term). To start with, until you know how your radio works, set TXDELAY fairly long. This sets the interval between when the transmitter is told to start and when signal is actually applied. I use TXDELAY 60 which sets 600mS (0.6 seconds). This amount should be fairly good for most medium to slow radios.

You should now have a working computer-TNC combination!

Step 9: (Ignore for BayCom) Set RF baud rate on TNC if it is a HF/VHF unit like TNC2s. Many of these TNCs have a switch which controls the baud rate (and tone combinations) used over the air. This need not be the same as the computer-TNC baud rate. In general, 1200 baud is used on frequencies higher than 10 Meters and 300 baud is used on frequencies below 10 Meters; both are used on 10 Meters.

Step 10: Connect your radio to the TNC. See Chapter 21 (Volume 2) for suggestions.

2.E.2 RADIO SETUP: Once the terminal and TNC are operating, the radio is the next item.

RADIO SETUP

Step 1: Connect a dummy load to your radio. If you don't have a dummy load, set it to lowest output power and use the worst antenna you have. For most of us, this is probably a "rubber duckie".

Step 2: Turn on the radio. It should not immediately transmit. There should be some kind of transmit indicator which tells you whether or not it is being keyed. This may be a light or some other indicator.

Step 3: Set your radio to simplex and tune to one of the packet frequencies. In the U.S., these are generally 144.900 MHz to 145.100 MHz. You will first want to choose a frequency not in general use. It is pretty safe to use an "even" frequency such as 144.92 or 144.94 because the commonly used frequencies are 144.91, 144.93, etc.

Step 4: With the TNC in command mode (from Step 7 of "Modem Setup"), enter a connect command. Since you will not really be connecting to anything, use any call or alphabetic name with 6 or fewer characters. An example might be: *C W7ABC*.

Step 5: You should see the PTT (push-to-talk) indicator on your TNC flash at regular intervals of a few seconds. Likewise, the transmitter must key every time the PTT indicator flashes. If so, you have the transmitter keying line properly connected.

Step 6: After a number of tries, the TNC should stop and you should see a message on the screen which says something like "*** retry count exceeded".

Step 7: Connect your radio to the antenna you expect to use. Select a frequency with packet activity. You can find this by disconnecting the TNC from your radio and listening as you tune from 144.90 to 145.10. On a packet frequency in use, you will hear rather irritating buzzes. Plug

the TNC back into the radio when you find a frequency.

Step 8: The DCD (data carrier detect) indicator on your TNC should flash regularly as packets are received. If not, adjust the volume control on the receiver. If there is still no DCD, you may not have received audio connected properly. Also, make certain that the RF baud rate setting on the TNC fits the situation you are operating.

Step 9: Assuming that the DCD indicator does flash, now try to monitor activity. For TNC2s, the command is *MON ON* ; for AEA TNCs, try "M 9". You should now start to see lines of strange characters appearing on your screen. In the font which will be used from now on to show text which the TNC sends to your terminal, it might look like:

```
KA7ZIN-15>N7ICS <RR R F R4>
SALEM>KA7ZIN <RR R F R4>
SALEM>KA7ZIN <RR R F R5>
KA7ZIN-15>N7ICS <I C P S3 R4>:Yeah, tell me about
it.  Well I will let u continue.  73, cul, KA7ZIN
K
```

You may need to adjust the transceiver audio level to get consistent copy by your TNC.

Step 10: You now need to set the deviation for your TNC and transceiver. In a sense, this is the loudness of your signal. Most TNC's have a transmit audio level adjustment. Remove the cover of your TNC and locate this adjustment with the aid of the instruction manual. You will need a small screwdriver (about 1/8" or 3mm blade). To initially make this adjustment, it is very desirable to have the use of another VHF radio. Tune it to the same frequency as you are using. Listen to other signals. Some of them may be weak with "hiss" in the back-ground while others will be fairly clear. Concentrate on the loudness of the clear signals.

Now, in command mode, type *CAL* or the equivalent for your TNC for calibrate. Press *K* to key the transmitter and note the loudness in your other radio. Don't leave your transmitter on any longer than absolutely necessary; press *K* again to turn it off. If your loudness is not similar to the others which you heard, adjust the transmit audio level in the TNC and try it again. When it is adjusted, type *Q* to return to normal operation.

This is a preliminary adjustment. See Chapter 22 (Volume 2) for detailed information about adjustment of deviation. You should now be ready for some on-the-air communication!

Here, a local conversation is one not using a node. Please note: in many areas, it is not considered "good practice" to carry on a conversation on a frequency with a local node without using that node; the reason for this should become clearer in Chapter 4. This section will show you how to make a connection without using a node. Understand that this may just be a learning step, depending on your local practice.

The following typographic conventions will be used in this and following sections: text FROM another station (including a node or BBS) are in this font; text from your TNC is in this font; *text you type is italicized*. (note that it does NOT appear italicized on your screen!)

A very useful metaphor for various aspects of packet radio is the telephone system. This will be used over and over to try to make the concepts somewhat more intuitive.

3.A MAKING A CONNECTION

Making a direct connection is like calling someone up on an old-style party line. You didn't need to use the operator. You could call the Smiths down the road by ringing 2 long rings and 1 short ring on the hand-crank phone.

You can do the same on packet. If you want to talk to W9ABC, you tell your TNC: "connect me to W9ABC". The TNC constructs an appropriate packet with your call, the call of the station you want to connect to, and the request to connect. The TNC causes this message to be sent out on your radio and it listens for a response from the other station. If there is no response, it tries again; this is called a "retry". The TNC tries a number of times controlled by a value which you can set in the TNC, then gives up if there is no answer.

3.A.1 FINDING SOMEONE TO TALK TO: One of the big questions asked by almost every new-comer to packet is: "How do I find somebody to talk to?" This question needs to be answered before discussing how to make your first connection. The way to start out is

to use the "heard" list kept by your TNC. In TNC2 clones, you get this list in the following way:

```
cmd: mh
AF7S-1        24-02-93  15:04:45
KB7QQH        24-02-93  15:04:18
SALEM         24-02-93  15:04:17
AA7JI         24-02-93  14:57:42
WA7SMO-15     24-02-93  14:54:39
K7IQI         24-02-93  14:53:13
K7MYU         24-02-93  14:51:39
N7ICS         24-02-93  14:41:43
K7UN          24-02-93  14:36:49
WA6SDR        24-02-93  14:13:09
cmd:
```

Note that this list comes from your TNC. Don't worry if yours does not have time and date or looks a little different. Note that some are not normal calls but names, like "SALEM" in the list above. These are usually from nodes or bulletin boards. Others are more-or-less "normal" ham calls. A few others look like ham calls with numbers on the end. These numbers have been referred to before as "SSID"s (Secondary Station ID). Many SSIDs indicate a node or a packet which has passed through a node; this will be discussed in more detail in later chapters. Others indicate mailboxes. Those callsigns without SSID's are prime candidates to talk to.

3.A.2 MAKING A CONNECTION: Lets try to connect to a station which isn't on the list. To request a connection, after the command prompt (remember that this means that you are "talking" to the TNC), simply use a *C* (for connect), a space, and the callsign, like this:

```
cmd: c w7abc
```

The TNC and radio will try several times. If the station really isn't there, the TNC responds with:

```
cmd:*** retry count exceeded
*** DISCONNECTED
```

This message tells you that the TNC tried in vain. Here is what happens when a connect is tried to a station which IS on the list:

```
cmd: c kb7hgj
cmd:*** CONNECTED to KB7HGJ
Please leave message @ KB7HGJ-1 Thanks <de Kevin> Chehalem
Mtn. Newberg,Or.
Hello, anybody home?
cmd: d
cmd:*** DISCONNECTED
```

Lets walk through what just happened. The connect command was given in the 1st line. The TNC responds with the *** CONNECTED to KB7HGJ message in line 2. This message comes from the TNC, not the other station. The other station, in this case, responds with a "connect message" in lines 3 & 4; this tells you to connect to KB7HGJ-1 in order to leave a message (see mailboxes in the next section). The typed query in line 5 goes unanswered, so a disconnect was made in line 6. This does not really show how the disconnect happened. In these simple cases, you must tell you TNC to disconnect you. Thus, YOU have to place the TNC into command mode; for most TNCs, a control-C (no ENTER or RETURN is needed) does it. The *d* is short-hand for "disconnect" and the TNC informs you when the task is finally accomplished.

Now, if someone actually had been on the other end, you could type back and forth. Once the connection occurs, the TNC automatically switches into "converse" or conversation mode. In this mode, the TNC is rather transparent, just sending on through (within some limits) what you type. Similarly, it receives what was typed on the other end and presents it to your terminal for display.

3.B MAILBOXES

Many TNC's have built in mail-boxes. If you leave your radio and TNC turned on all the time, other packet stations can leave mail in your TNC.

Mail-boxes are much like simple bulletin boards so we won't go into great detail now. There are several styles. A common one looks like this when you connect:

```
[KAM-5.0-HM$]
6218 BYTES AVAILABLE
Welcome to Oregon, please leave me a message.
ENTER COMMAND:  B,J,K,L,R,S, or Help >
H
B(ye)         PBBS WILL DISCONNECT
J(heard)      CALLSIGNS WITH DAYSTAMP
J S(hort)     HEARD CALLSIGNS ONLY
J L(ong)      CALLSIGNS WITH DAYSTAMP AND VIAS
L(ist) [;]    LIST MESSAGES YOU CAN READ
L <|> call    LIST MESSAGES FROM OR TO CALL
LB            LIST BULLETINS
LC [cat]      LIST CATEGORIES
LL n          LIST LAST n MESSAGES
LM(ine)       LIST UNREAD MESSAGES ADDRESSED TO YOU
LT            LIST TRAFFIC
K(ill) n      DELETE MESSAGE NUMBER n
KM(ine)       DELETE ALL READ MESSAGES ADDRESSED TO YOU
R(ead) n      DISPLAY MESSAGE NUMBER n
RM(ine)       READ ALL MESSAGES ADDRESSED TO YOU
S(end) call   SEND MESSAGE TO callsign
SB call       SEND BULLETIN
SP call       SEND PRIVATE
ST call       SEND TRAFFIC
ENTER COMMAND:  B,J,K,L,R,S, or Help >
```

While this one may be a little more elaborate than some, it is not much different than many of the mailboxes on the air. You can disconnect by sending it a *b* (for bye) or you may disconnect from your end.

There is one important distinction between mailboxes; some are full-time and some must be turned on and off. Full-time ones usually use a specific SSID for the mailbox and another SSID for "talk" with the operator (as in the example of the previous section). Part-time mailboxes use only one SSID; these must be turned on when keyboard operation is completed, then turned off when keyboard operation is restarted.

3.C DIGIPEATING

What do you do when the station you wish to talk to is not quite in radio range? The first solution developed for packet radio is called digipeating. While still used, it is no longer the only solution. It has its place and its limitations which are discussed in the last section of this chapter.

3.C.1 CONNECTING USING A DIGI: Digipeating uses one or more other stations to relay your message to a distant destination. Lets suppose that you are on one side of a mountain, W7ABC is on the other, and, as in our example in section 3.B, connect requests are not successful. Lets suppose that AA3ZZ is fortuitously located on top of the mountain. See Figure 3-1. We can use AA3ZZ as a digipeater (or, digi for short) by requesting that our TNC try to connect to W7ABC via AA3ZZ. The command to the TNC looks like this:

```
cmd: c w7abc v AA3ZZ
```

There are several things to note from this command. One is that callsigns can be entered in either upper or lower case. You can spell out *via* or use the shorthand, *v* .

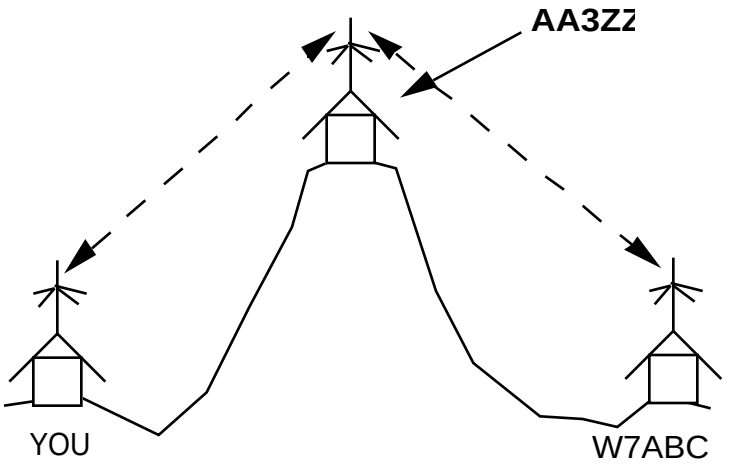

FIGURE 3-1, DIGIPEATI

If more than one digipeater is used (the packet format permits up to 8), the digipeater callsigns are listed in the order in which the packet encounters them leaving your station, separated by commas. Thus, an acceptable request might be

```
cmd: c w7abc v AA3ZZ, N1A
```

where AA3ZZ is the first digipeater encountered by your signal, N1A is the second, and W7ABC, your destination, is the last.

3.C.2 HOW DIGIPEATING WORKS: Every packet has a portion which you do not normally see. This portion, the header, contains the call of the station which sent the packet and the call of destination of the

packet. There is also room for a number of digipeater calls.

When a station which is able to digipeat hears its callsign in the digipeat call portion of the header, it listens to the packet. If the packet is received error-free, it resends it. In this way, a whole chain of stations may pass a packet from one to the next.

3.D LIMITATIONS

In the early days of packet radio, digipeating was widely used. One could use a string of digis to go all the way from Portland, Oregon to San Francisco. If this is possible, why is it not as widely used now?

One answer is that digipeaters don't know anything about neighboring digis. You have to find out by asking and exploring. Nodes have solved this problem by managing routing in a much more straight forward manner.

Another answer has to do with error management. Suppose, in our previous example, there was noise which interfered with one of your packets as it was sent by AA3ZZ to W7ABC. If the error wasn't too bad, W7ABC sends back a packet saying that there was an error and your TNC repeats. If the error was really bad, W7ABC's TNC does not even know that there was a packet and simply does not acknowledge (which it does with a successful reception). In this case, also, your TNC waits, then repeats. In both cases, the packet gets resent from you to AA3ZZ and from AA3ZZ to W7ABC. Thus, the repeat packet is resent twice, occupying the frequency twice. If a node were used instead of a digi, the error is resolved between the node and each participant. Repeat packets are only sent between the node and the end station.

Even with these limitations, digipeating still has its place. If you are out of range of a node, digipeating may be an answer. If your local node fails, digipeating may also help (temporarily). Thus, while of more limited use than in the "good old days", digipeating still has a place if used wisely.

3.E ANTENNAS

As mentioned earlier, antennas are a major discussion point. Among packeteers, the issue is usually between directional and non-directional antennas. Here, we will try to look at the advantages and disadvantages of each. In general, the conclusion seems to be that there is no one "right" answer. It may, in fact, take some experimentation to determine what is best for you. Lets first talk about some of the issues before looking at how each antenna type stands up.

3.E.1 MULTI-PATH: Multi-path is a problem which arises when radio waves follow two different routes from the transmitter to the receiver. The end result happens when the two routes are of different length. If the length differences are just right, the two signals can interfere with each other "destructively". Multi-path is quite obvious when watching television; it produces the irritating "ghost" images. It can also be quite obvious when operating VHF mobile; there are spots where signals fade almost completely and there are others, often only a few feet away, where signals are strong.

The effect can be seen on any frequency, including HF. It is easily seen on VHF and often seems more pronounced as you go up in frequency. For a variety of reasons, multi-path problems increase at higher RF baud rates.

3.E.2 HIDDEN TRANSMITTERS: The hidden-transmitter problem is as old as packet radio. This problem is the result of the "carrier sense" scheme which TNCs use to avoid packet collisions. A collision occurs when two packet stations transmit at the same time, spoiling all or part of the other's packet. TNCs try to avoid this by not transmitting when another is transmitting. But if a frequency is vacant for a little while, two TNCs may decide to transmit at about the same time, each unaware of what the other is going to do. This part is an unavoidable consequence of time-shared operation with the protocol (set of rules) which govern our TNCs.

The hidden transmitter problem is in addition to the situation just described. To see its causes and effects, lets go back to section 3.C where digipeating is discussed. In that example, there is a hilltop station, AA3ZZ. It serves as a digipeater for two stations, (you and W7ABC) on opposite sides of the hill. Now, suppose that W7ABC has started to transmit. Your station cannot hear it because it is on the other side of the hill. So, your station can transmit, oblivious of the other station.

AA3ZZ is now in a tough situation because it hears both at the same time. This is the hidden transmitter problem.

3.E.3 NON-DIRECTIONAL ADVANTAGES: Non-directional antennas have been the historical choice for many packet stations. The reasons are fairly clear. With stations in a variety of directions, non-directional antennas are much easier. Particularly when digipeating is involved, signals may come from several directions at the same time, making non-directional antennas almost a requirement.

Non-directional antennas are fairly inexpensive to purchase when compared to directional antennas. Because of simpler construction, non-directional antennas tend to be more resistant to severe weather but this is not always true.

Non-directional antennas are simple to construct. J-poles and gound-plane verticals are frequently used. 5/8-wave verticals can supply some gain over a 1/4-wave vertical at the expense of a little more complexity.

3.E.4 NON-DIRECTIONAL DISADVANTAGES: One of the major disadvantages of non-directional antennas is the inability to discriminate between signals involved in multi-path problems.

3.E.5 DIRECTIONAL ADVANTAGES: The gain of a directional antenna may provide enough added signal on both receive and transmit to improve operation in low-signal areas. If low signal strength is causing retries, the packet rate from your station (and whom ever you are connected to) will improve. The reduced retry rate will reduce the time your packets occupy the frequency.

If multi-path is a problem at your location, a directional antenna may improve the situation considerably. It is somewhat tricky to aim the antenna for best results, but when you do, the improvement can be considerable.

3.E.6 DIRECTIONAL DISADVANTAGES: A directional antenna makes it difficult for other stations to use yours for a digipeater. In most areas, this is not an issue; but where it is, consider it. If you use nodes in a variety of directions, you may have to re-aim your antenna for each one. This is annoying and you are out the cost of an antenna rotor.

A directional antenna may make it difficult for your station to hear others

on the same frequency. Thus, you and those stations become hidden transmitters to each other. This effect may increase problems rather than decrease them.

3.E.7 TESTING: If you have decided to try a directional antenna, it may be worthwhile to borrow one for a short time to see if the results are worth the effort.

One of the best tests is to make a side-by-side comparison with your normal antenna. Set the two antennas up, a short distance apart. Bring coax from both to a point where you can easily change from on to the other. A useful measure is the retry rate. Try connecting to a station or a node (see next chapter). Send a very simple packet (maybe one with just a question mark). Watch how many times the PTT light flashes before the STA light goes out; this light is on when your TNC has an undelivered packet in it. Then change to the other antenna and try the same experiment. You might want to try it several times with each because the result can be effected by the amount of traffic on the frequency. If the retry rate is clearly lower with one antenna as compared to the other, that is likely the "better" one for you.

You might also check to see how the retry rate compares at normal transmit power and the lowest transmit power available. This test tends to emphasize low signal strength conditions.

3.F BASIC TNC PARAMETERS

Most of the TNC parameters are convenience items. There are only a few which effect the performance of your packet station. We will focus on those in this section.

3.F.1 MYCALL: You MUST set your call into the TNC. Usually when a TNC is brand new, the callsign is set to something like "NOCALL". Most nodes and other stations will not accept a connect request from NOCALL. You are also illegal because you are transmitting without identifying yourself! The TNC2 command is: `cmd:`*`mycall callsign`*.

3.F.2 DIGIPEAT: You can specify whether or not other stations can use yours as a digipeater. It is normally allowed. If there is a reason why you don't want it used this way, the TNC2 command is `cmd:` *`digi off`*

or cmd:*digi on.*

3.F.3 DWAIT: This value is important primarily if you use other stations as digipeaters. It helps to keep your transmitter from sending one packet too soon after another which a digipeater may be resending. If you commonly use digis, try increasing this value. In TNC2s, the units you specify are in increments of .01 seconds (that is, 10 milliseconds). You might try setting DWAIT in this case around 0.5 seconds, or cmd: *dwait 50.*

3.F.4 PACLEN: The PACLEN parameter controls the maximum length of your transmitted packets. Normally, this only comes into play if you type very long sentences without "returns" or "enters" at the right edge of the screen. When you type a number of characters (including spaces) equal to the PACLEN value, the TNC will automatically send a packet.

You can often improve the retry rate if you make this value smaller when your signal is poor. It is also usually made fairly small on HF. There is a point of diminishing returns, however, because the header of every packet is about 25 characters. If you set PACLEN to 25 characters, the total length is really about 50.

When conditions are very poor, you can achieve the same effect by making your lines short. If you press the enter key about mid-screen (on an 80 character screen), your packet length will be about 40 text characters (for a total length of about 65 characters).

3.F.5 RETRY: This is the number of times your TNC tries to send a packet before it gives up. On a reasonably good frequency, a value of 4 should be adequate. If you keep getting:

```
*** retry count exceeded
*** DISCONNECTED
```

then your retry value may be too small. This may be happening because the path between you and the other station is poor or because of other activity on the frequency (ie, hidden transmitters!)

But also remember that when you raise the retry value, you are increasing the number of packets on the frequency which makes it harder for others who may increase THEIR retry values which makes it even harder for you, etc.

3.F.6 TXDELAY: This is perhaps one of the most important performance parameters. This value determines how long your transmitter is turned on before the actual packet starts. Older radios often require longer TXDELAY. This is particularly true when the radio has a mechanical transmit/receive relay. If there is such a relay, you can often hear it "click" each time you transmit. For TNC2 type TNCs, the delay units are in steps of 10mS (that is, 0.01 seconds). A value of 1 gives 10ms, a value of 2 gives 20ms, etc. Most slow radios should be adequate with: cmd: *TXD 60*. Newer radios should be good with a value of 30 or less.

It is important not to set this value longer than really necessary. A 150 character packet (including header) takes a little over 0.125 seconds. If you make TXD a value of 60, the total time your transmitter is on for each packet is about 0.725 seconds. Thus, most of the "on" time is "warm-up" but it is still occupying the frequency. Thus, this time is really wasting the capacity of the frequency if it is not really necessary.

3.F.7 SLOT TIME & PERSISTENCE: Many newer TNCs have a pair of parameters named slot time and persistence. Once the TNC detects that the frequency is not occupied by another transmitter and it has a packet to send, it waits a time interval of slot time. Then it generates a random number; if the random number is less than the persistence, it transmits; if the random number is greater than the persistence, it does not transmit. If it does not transmit, it waits another slot time and tries the random number again.

In general, the random numbers fall in the range of 0 to 255. Thus, if you set persistence to 128, then, on average, it will transmit on one-half of the tries; if you set persistence to 64, it will transmit on one-quarter of the tries. If you operate on a busy frequency, choose smaller values for persistence; if 4 users is pretty common, try 64 but if 2 or fewer are the rule, then 128 is reasonable. The common rule is to choose a number which is about 256 divided by the average number of simultaneous users on the frequency.

For information about other TNC parameters and how to set them, see section 4.G.

Once you have had a few conversations on packet and have started to find your way around your neighborhood network, many questions start to come up.

Chapter 5 attempts to provide you with information about the basic idea of servers; though this name is not frequently used, what it represents pervades our system. Chapters 6, 7, 8 & 9 try to provide working information about bulletin boards, DX spotting, and network operation. Chapter 10 discusses some of the basics of AX.25. Detailed information about bulletin boards and nodes (networking) is found in Volume 2.

In this chapter, we try to explore some of the more general operating questions which frequently come up.

4.A OPERATING HINTS

4.A.1 OPERATING POWER & RETRIES: FCC regulations require us to use the minimum power consistent with reliable com-munications. In the case of packet, reliable communication translates into low retry rate. Increasing power may reduce the number of retries your station takes to deliver a packet. But if the station at the other end requires many retries, you still have a problem. If the other station is a personal station, it may increase power, use a directional antenna, or use a digipeater. But if the station is a hilltop node, there isn't much that can be done at the that end. In this case, you may reduce retries on both ends with a directional antenna (and low power, all at the same time!)

For poor link quality, some simple rules might help. Increasing your power (usually) decreases your outgoing retries but but have no effect on incoming retries. Higher gain antenna should decrease both incoming and outgoing retries. A properly aimed directional antenna should reduce incoming retries; it may reduce outgoing retries unless it makes you a hidden transmitter to other users.

4.A.2 CHANGABLE PROPAGATION: Many areas experience seasonal and weather changes in VHF propagation. At the author's location, several nodes are available. The closest one (about 15 miles, line of sight) is quite variable, changing with weather and season; this may be partially attributable to relatively low power (a few watts). Another node, (about 30 miles, just out of line of sight) is quite reliable but, during heavy use times, is fraught with hidden transmitter problems. When you are unable to connect with your favorite node, don't immediately assume that it is a node problem. If your area is prone to fall temperature inversions (morning fog is a good indicator), this time is often especially difficult for propagation.

Packet tends to be more sensitive to propagation than voice. While you may be able to understand a poor quality voice signal, packet is less tolerant.

4.B KEYBOARD USE

When you type, there are two very significant things to remember. The first has to do with packets sent to your TNC; the second has to do with compatibility with various computers.

4.B.1 UNDOING WHAT HAS BEEN TYPED: Unless you change your TNC parameters, the send packet character is a carriage return (*enter* or *return*). Once this key has been pressed, the characters you have typed are formed into a packet and stored for sending. Unless you use a special cancel packet command (for TNC2s, see *CANPAC*), what you have sent is forever beyond your control. You cannot fix errors, etc, after that point. What is done is done.

Prior to the carriage return, you can backspace to your heart's delight, up to the first character following the preceding carriage return. Author's advice: hurrying or disliking the backspace key is no excuse for poor spelling!

4.B.2 COMPATIBILTY WITH OTHER COMPUTERS: One of the dilemmas is how to keep what is typed compatible with other computers. There are few computers left with 40 character lines (the Apple II was one). There are many with 64 character lines (Commodore C64s among them). Displays with 80 character widths are common but not universal. So what do we do?

If the other person uses a carriage return at the end of each line, you will see exactly what their screen width is. If you do the same, they will see yours. The strategy is for the one with the wider screen to use the carriage return at the same place on their screen as with the incoming packets.

Not all computers recognize all of the characters which can be sent by other computers. A common character in this category is the TAB character. Unless two computers have the same TAB settings, text with TABs will come out strange on the other screen. The simple solution is to just avoid TAB!

Also avoid relying on automatic line-wrap. Many terminal programs automatically insert carriage returns at the end of the screen, whether you press the key or not. Many others do not. Many terminal programs have problems with text containing very long lines (longer than 256 characters, in particular). This is what happens when you rely on line wrap with a terminal program which does not insert carriage returns. For this reason and the others outlined above, please just use that enter/return key at the right-hand end of each line!

See also Chapter 13, section A, for comments pertinent pre-typed text files.

4.C THAT BLANKETY-BLANK "*** DISCONNECTED"

When using very busy nodes or nodes which link on the same frequency as that the user frequency (see section 8.D), surprise disconnects can be quite frequent. There is one common cause and another less common cause. A disconnect happens when your station or the station at the other end has exceeded its retry limit for your connection. If the station at the other end (or somewhere else in a circuit of several nodes) retries out, you get:

```
*** DISCONNECTED
```

from your TNC. But if YOUR station retries out, you get:

```
*** retry count exceeded
*** DISCONNECTED
```

The most common cause is the hidden transmitter situation (see section 3.E.2). One of the problems is that it is quite difficult to tell when it is happening. See section 4.D for information which might let you know when it is happening.

The less common cause is a change in propagation which causes the link to degrade. Possible, but very unlikely, causes are equipment failure at either end or accidental disconnect commands.

4.D WHAT THE TNC MONITOR FUNCTION TELLS YOU

The TNC's monitor capability can let you observe what is happening on your operating frequency. The monitor display can also be pretty confusing. And its format is not the same for all TNCs. To understand what is shown, it is necessary to look first at the several basic packet types.

4.D.1 PACKET TYPES: There are about six basic packet types. Each serves a specific purpose. Connect (C) packets are used exclusively for connect requests; these are also known as SABM packets. Information (I) packets contain characters in the body of the packet. Unnumbered Information (UI) packets are sent out to nobody specific (as in CQs or beacons); these packets can also be thought of as Unconnected Information. UI packets are also the basic communication medium of TCP/IP (See Chapter 10). Disconnect" (DISC) packets are used exclusively for disconnect requests. Disconnected Mode (DM) packets are used to signal that a station is unable to accept a connect request. Unnumbered Acknowledge (UA) packets are used to acknowledge the receipt of either connect or disconnect requests.

The packet types which tell the most about frequency congestion and retries are the RR, REJ and RNR packets. An RR packet (Receiver Ready) is used to signal the error-free receipt of a packet. An RR packet is in response to an I packet. I packets are numbered in the pattern 0,1,2...,6,7,0,1,... ; the RR packet indicates the number of the I packet is is acknowledging.

RNR (Receiver Not Ready) packets are seen most often from nodes or bulletin boards. It means that the station cannot receive any more packets. The usual cause is that packets which must be sent on somewhere else have not been delivered. Thus, they are building up in the station and occupying memory (buffer) space. When the station has

run out of space for that conversation, it sends an RNR; when it is able to accept more, it sends an RR.

REJ (Reject) is sent when a packet has been received with an error. It is a request to resend the packet. The REJ packet contains the number of the I packet which had an error.

4.D.2 CONGESTION SYMPTOMS: Congestion is easily seen because packets have both the TO and FROM callsigns in them. Hidden transmitters are particularly obvious when you see only one-half of a conversation (see 4.E because there is more than one reason for seeing only half of a conversation). When there are more than 6-8 stations on a single frequency, even if not hidden, collisions become significant.

4.D.3 POOR LINK SYMPTOMS: Link quality is best observed during a light traffic time. If there are few other users on the frequency and both your station and the station you are in contact with require several retries per packet, the link is poor. Sometimes the excessive retry rate may be one-sided such as when one station has much more transmit power than the other. Retries can be seen by watching the PTT indicator on your TNC; every time it flashes after you press the enter/return key is a TRY. Expect one flash; more are retries.

4.D.4 MONITOR DISPLAY: For starters, lets look at an example of a TNC2-style monitor display of a complete connect & disconnect process.

```
cmd: c lyons
cmd:*** CONNECTED to LYONS
c 1 ka7upd
KA7EHK-15>KA7UPD <C C P>
KA7UPD>KA7EHK-15 <UA R F>
KA7UPD>KA7EHK-15 <I C S0 R0>:Mailbox ready
LYONS:KA7UPD-1}  Connected to KA7UPD
KA7EHK-15>KA7UPD <RR R F R2>
Mailbox ready
Mailbox (B,H(elp),K,L,R,S) >
b
KA7EHK-15>KA7UPD <I C P S0 R2>:b
KA7UPD>KA7EHK-15 <D C P>
KA7EHK-15>KA7UPD <UA R F>
*** DISCONNECTED
```

The first 2 lines show a connect to a node. The 3rd line is a connect request for G8BPQ style nodes. The 4th line is the connect request BY THE NODE on behalf of KA7EHK (see section 4.E for an explanation of

the SSID change). The 5th line is an acceptance by KA7UPD of the connect request back to the node. This is followed immediately by the mailbox logon message by KA7UPD. Note that this is an I packet which is numbered R0. The next line is (finally) the notification by the node that the connect request was successful. The 8th line with the RR packet is an acknowledgement by the node of successful receipt of the preceding packet(s). The next 2 lines are the response from the KA7UPD mailbox as it actually comes out of KA7EHK's TNC. Note that there is one more line here than monitored between KA7UPD and the node. This packet was probably received with an error at the monitoring site and, thus, not shown. The next line is the bye command to KA7UPD's mailbox from KA7EHK. The I packet numbered R2 from the node (KA7EHK-15) to KA7UPD is the bye command being sent by the node to KA7UPD. That is followed by the disconnect (D) packet as sent by KA7UPD mailbox. That is, in turn, followed by the receipt acknowledgement for the disconnect by the node. The very last line shows the TNC's response to the disconnect from the node.

Next, lets look at a situation where the other station is hidden:

```
cmd:c valley
cmd:*** CONNECTED to VALLEY
c n7fgf
KA7EHK-15>N7FGF <C C P>
VALLEY:N7FGF-3}  Connected to N7FGF
KA7EHK-15>N7FGF <RR R F R1>
[AEA PK-88]  19096 free  (A,B,H,J,K,L,R,S,V,?) >
b
KA7EHK-15>N7FGF <I C S0 R1>:b
KA7EHK-15>N7FGF <UA R F>
*** DISCONNECTED
```

In the preceding case it all goes like the first example except that there are no monitored packets from N7FGF. There are two minor differences: (1) this is a TheNet node and the connect command is a little different than G8BPQ nodes, and (2) the mailbox response has only one line instead of two.

What was just shown in the first two examples are nearly ideal packet transactions. Lets look at a little more normal situation. We will take this in sections to make it a bit simpler. Remember, however, that the next several boxes are part of a single monitoring log of only a few minutes duration.

```
SALEM>N7TRJ <UA R F>
SALEM>N7TRJ <UA R F>
SALEM>N7TRJ <RR C P R0>
SALEM>N7TRJ <I C P S0 R0>:Welcome to the Salem Packet
Switch
Type ? for list of available commands.
SALEM>N7TRJ <RR R F R1>
SALEM>N7TRJ <RR R F R2>
```

From the previous examples, we can interpret these lines pretty easily. The first 2 lines are the node's response to N7TRJ's connect request. Finally, in line 4, the node logon message is sent. This is followed by RR packets acknowledging two packets from N7TRJ. We cannot tell what these packets are because N7TRJ is hidden from the monitoring site.

```
SALEM>KB7NZ <UA R F>
SALEM>KB7NZ <I C P S0 R0>:Welcome to the Salem Packet
Switch
Type ? for list of available commands.
SALEM>N7TRJ <RR R F R3>
SALEM>KB7NZ <UA R F>
SALEM>KB7NZ <RR C P R0>
SALEM>N7TRJ <RR R F R4>
SALEM>KB7NZ <RR R F R0>
SALEM>KB7NZ <RR R F R1>
SALEM>KB7NZ <RR C P R1>
SALEM>KB7NZ <I C P S0 R1>:Welcome to the Salem Packet
Switch
Type ? for list of available commands.
```

In the midst of N7TRJ's node activities, now KB7NZ is making a connect request. This can be determined in line 1 because of the UA packet which is an acknowledgement of a connect request. This is immediately followed by the node logon message to KB7NZ. But not all is well with KB7NZ because a second connect acknowledge appears in line 5. This means that KB7NZ made a second connect request because the first acknowledge was not heard. Then, at the end, the logon message is sent again. Note that this time, it is numbered R1 while the first was R0. Note, also, that when several RR packets are sent to the same station with the same R number, it indicates that the station did not hear the earlier acknowledgement and resent the same packet, thus generating a new RR acknowledgement.

```
SALEM>KB7NZ <I C P S1 R1>:SALEM:AF7S-1}  Connected to
SRABBS:N7IFJ

SALEM>KB7NZ <I C P S2 R1>:[MSYS-1.12-H$]

SALEM>KB7NZ <I C S3 R1>:Hello Bob, Welcome to N7IFJ's MSYS
BBS in Salem, OR

SALEM>KB7NZ <I C P S5 R1>:Enter command:
A,B,C,D,G,H,I,J,K,L,M,N,P,R,S,T,U,V,W,X
,?,* >
```

KB7NZ sent the node a command to connect to SRABBS. We did not see that request, only notification of the connect. The connect has happened on another port (frequency) of the node and is not visible here. This is followed by the BBS logon message to KB7NZ. These packets are sent but we do not see KB7NZ's acknowledge-ment of each because that transmitter is hidden from the monitoring site. Also, there is a missing packet (S4) which was not shown because of errors in the received packet at the monitoring site.

```
SALEM>N7TRJ <I C P S1 R4>:SALEM:AF7S-1}  Connected to
BEND:K7YLO-1
SALEM>N7TRJ <RR R F R5>
SALEM>KB7NZ <RR C P R1>
```

Now, in the first line, we see the node notify N7TRJ that a connect request to the distant node BEND is successful. It appears to be followed in the 3rd line with the acknowledgement of another packet from N7TRJ.

```
SALEM>KD7YB <UA R F>
SALEM>KD7YB <I C P S0 R0>:Welcome to the Salem Packet
Switch
Type ? for list of available commands.

SALEM>N7TRJ <RR C P R5>
KD7YB>SALEM <RR R F R1>
SALEM>KD7YB <RR R F R1>
SALEM>KD7YB <I C P S1 R1>:SALEM:AF7S-1}  Connected to
SRABBS:N7IFJ
```

Here is yet a third connect request to the node, this time by KD7YB. And, like KB7NZ, a connection to SRABBS was requested. This time, however, KD7YB is not hidden from the monitoring site.

```
KD7YB>SALEM <RR R F R2>
SALEM>KD7YB <I C S3 R1>:Hello Joan, Welcome to N7IFJ's MSYS
```

```
BBS in Salem, OR
SALEM>KD7YB <I C S4 R1>:Use  D HELP.DOC to download a help
file (Tnx to KA7ZIN), enjoy.

SALEM>N7TRJ <RR C P R5>
KD7YB>SALEM <REJ R R2>
SALEM>KB7NZ <RR R F R1>
SALEM>KB7NZ <RR R F R2>
SALEM>KD7YB <RR C P R1>
SALEM>KD7YB <I C S2 R1>:[MSYS-1.12-H$]

SALEM>KD7YB <I C S3 R1>:Hello Joan, Welcome to N7IFJ's MSYS
BBS in Salem, OR
SALEM>KD7YB <I C S4 R1>:Use  D HELP.DOC to download a help
file (Tnx to KA7ZIN), enjoy.

SALEM>KD7YB <I C P S5 R1>:You have unread mail, please kill
when read:

SALEM>KB7NZ <RR C P R2>
SALEM>KD7YB <I C P S0 R1>:Enter command:
A,B,C,D,G,H,I,J,K,L,M,N,P,R,S,T,U,V,W,X
,?,* >

KD7YB>SALEM <RR R F R1>
```

The preceding group of monitored packets includes a REJ. This means that the node received a packet from KD7YB and that packet contained an error. The REJ packet is a request to resend the packet with the error. It is difficult from this point to associate which packet had the error and that is not so important to us anyway. It simply shows us how an error is shown.

```
SALEM>KB7NZ <I C S3 R2>:Hello Bob, Welcome to N7IFJ's MSYS
BBS in Salem, OR

SALEM>KB7NZ <I C S4 R2>:Use  D HELP.DOC to download a help
file (Tnx to KA7ZIN),
 enjoy.

SALEM>KB7NZ <I C S5 R2>:Enter command:
A,B,C,D,G,H,I,J,K,L,M,N,P,R,S,T,U,V,W,X,?,* >
```

The preceding example does not really give a sense of the activity during the monitoring interval. This was observed over an interval of only a few minutes. And there were only three users present. Yet there were many packets passed! Among the three users, there were remarkably few retries. This is a very desirable condition but not that common when things are busy.

4.E MORE ABOUT SSIDs

There have already been 3 discussions concerning SSIDs (step 8 of "Setting Up the Modem" in section 2.E.1, section 3.A.1 and section 3.B). Here, the focus is on what happens to an SSID in a node.

First, consider the SSID for your own station. When you set the TNC2 parameter *mycall callsign* and just use your own call, a SSID of "0" is assumed. Other SSIDs for TNC2s is set with *mycall callsign-SSID*. For example, if N9AA wants an SSID of 5 for a TNC2, the entry would be *mycall N9AA-5*.

When you use a Net/Rom-style networking node (which is the case throughout the west), the node adopts your call (modified) for all outgoing packets to anywhere other than your station. It puts an SSID on the call. The number it uses is 15-(your SSID). Thus, a node to which KA7EHK connects becomes to others KA7EH-15. KaNodes subtract 1 (MOD 16) from the SSID; an SSID coming in as 5 comes out 4 and one coming in as 0 goes out 15.

But why all the monkey business with SSIDs? Suppose that you connect to your friendly local node and tell it to connect you to W0XYZ. Suppose, furthermore, that W0XYZ is not very far from you. The connect request is successful. What would happen if that SSID is not changed? Your TNC could not tell whether W0XYZ's packets are for the node or for you, directly. Since the node is (usually) your call with an SSID of 15, returning packets are addressed to that SSID and there is no confusion.

There is a potential trap involving combinations of Net/Rom nodes and KaNodes. It has to do with the differing ways the two change incoming SSIDs into outgoing SSIDs. The author discovered this situation while exploring a local KANode. Suppose that you adopt an SSID of 0 and connect to a local KaNode. Then, on the SAME frequency, you connect to a Net/Rom-style node. The outgoing SSID from the KANode is 0-1=15 and that is the incoming SSID at the Net/Rom node. If you then try to connect to another local station on the same port of the Net/Rom node as that on which you entered, you go out as SSID = 0. Now, the KANode can't distinguish between your packets and those from the Net/Rom node and a fearful lockup may ensue. There are several other

combinations where the same result may occur.

It is also worthwhile noting about SSIDs as packets go through a network of Net/Rom. Any time you autoroute to a neighboring node, you appear with the same SSID you would outgoing locally. It makes no difference how many nodes you pass through; the SSID stays the same. When you make an outgoing connect at a distant node, it is with the same SSID as it would be with a local connect.

In section 4.D.2, it was mentioned that hearing a station with an SSID of 15 but not hearing the call without an SSID is an indicator of a hidden transmitter. This is true. But there is also another reason for this to happen. If a station at a distant node has made a network connection to your node, then made a connection out to a local station, you will also see only the call with an SSID. The only way to tell which is the case is to connect to the node and obtain a User list (see Chapter 24 in Volume 2 for more information).

4.F OPERATING ON NODE FREQUENCIES

After antennas, the next most common point of contention is about operating on the same frequency as an active node without using that node. As with most such debates, there are of course, at least two correct answers!

4.F.1 ADVANTAGES OF OPERATING WITHOUT A NODE: If you do connect direct to another packet station (say a BBS) on a node frequency, you reduce the number of packets by 50%. Instead of one packet between you and the node and a second packet between the node and the other station, there is only one. Thus, your impact on the frequency is only half.

An observation is in order: if you do choose to operate this way and it is possible for both stations to change frequencies, do so!. If 145.01MHz is a no-node frequency in your area, use it. This also appears to be a legitimate use of 145.50-145.80MHz for this is genuinely miscellaneous (this is an FCC set-aside no-repeater subband). Likewise, 146.40-146.58MHz is simplex (ARRL Band Plan) and packet is, without any debate, simplex. Any of these frequencies away from normal packet operation could not help but go better than trying to compete with a node and its users!

4.F.2 DISADVANTAGES OF OPERATING WITHOUT A NODE: One of the arguments against direct connects on a node frequency is that the node serves as traffic control on the frequency. Lets look at this argument and attempt to determine whether it is valid.

Suppose that that there is a hilltop node called NODE. Two users, A & B, are on one side of the hill. Another user, C, is on the same side of the hill as A & B. C is talking to D though NODE while A is talking to B directly. So, what happens? A,B,C, and NODE all hear each other; NODE and D hear each other. A, B, & C avoid collisions simply because they can sense each other's carriers. This happens without regard to the presence of NODE. D, on the other hand, collides with A,B, & C as heard by NODE (as well as the other way around) because they are hidden from each other. NODE is in a different situation; when it has a packet to send from D to C (or C to D), it waits its turn because it can hear all four.

Now, suppose that A & B change their link so that NODE is used. Is it any better? The number of packets increases as pointed out in section 4.F.1. The RR (acknowledgement) packets issued by NODE appears to modify the transmit pattern a little and reduce the collisions heard by NODE. But the effect does not seem to be large.

Comment: it does appear that a small improvement in collision rate at the node does happen. There certainly are more packets on the frequency. If the collision rate is, indeed, reduced, there will be fewer retries but, again, the reduction seems small. Thus, it appears that the cost of operating on a node frequency without the node is not very high. But, why battle? Change frequency if possible!

4.G TNC PARAMETERS

TNCs have basically three sets of parameters. One set controls the radio operation of the TNC. One set controls the relationship between your terminal and the TNC. The last set controls the convenience features.

In the following discussion based on TNC2 style commands, there is usuall a short and long version of each command. The short version is usually the first few letters of the long version. The short vesion may be used by itself; if the long version is used, it must be spelled correctly and

in full. Most TNCs accept either upper or lower case letters in the commands. Commands will be denoted as XX[yyy] where XX is the required short form of the command and yyy is the optional remainder of the command.

4.G.1 RADIO PARAMETERS: In TNC2 style, these are AXD[elay], AXH[ang], CH[eck], DW[ait], FR[ack], MAX[frame], MY[call], P[aclen], RES[ptime], RE[try] & TX[delay]. With some newer TNCs which use somewhat different internal rules for timing retries, SLOT[time] and PER[sist] are also in this group of parameters.

Unless you are using a voice repeater, AXD[elay] and AXH[ang] should be 0. AXD[elay] accounts for slow response time of most voice repeaters and AXH[ang] accounts for the usual voice repeater squelch tail.

DW[ait] is used to account for characteristics of digipeaters but affects general operation also. For TNC2s the value of DW[ait] is in 10mS (10 milliseconds or .01 seconds). A value of 1 produces a 10mS wait; a value of 15 produces a 150mS wait. This wait is between when the TNC detects a clear frequency and when it begins to transmit.

TXD[elay] is used to control two aspects of operation. It, also, is a time interval. Also, in TNC2s, it is in units of 10mS. On every transmission, when the transmitter is keyed, there is a wait until data sending actually begins. This is because some transmitters take much longer than others to establish normal operation when keyed. This parameter is also used to reduce collisions on retries. On retries, an extra delay is added to DW[ait]. This delay is a random amount. The idea is that if two transmissions collide, if they wait exactly the same interval for their retries, they will collide again. The extra delay is a random number times TXD[elay]; the random number varies on each retry from 0 to 15. Thus, after the first (unsuccessful) try, the wait might be DW[ait] + 7*TXD[elay]. The next time, it might be DW[ait] + 3*TXD[elay]. Remember, this is the interval between sensing a clear frequency and transmitter keyup. There is still always a wait of TXD[elay] between transmitter keyup and start of data.

FR[ack] controls how long the TNC waits for an acknowledgement before assuming that none is coming. In TNC2s, this is in units of 1 second. When a digipeater is used, the wait time is lengthened according to the number of digis used (at the rate of 2 FR[ack] intervals per digi). If this value is set too small, your TNC will send retry packets when

they are not needed. FR[ack] should generally be set quite a bit longer than RES[ptime].

RES[ptime] is the complement of FR[ack]. This is the MINIMUM wait time for packet acknowledgements. For TNC2s, this is in units of 100mS (0.1 seconds). It comes into play primarily when many packets are being sent rapidly as in file transfers.

P[aclen] sets the largest packet which your TNC will send. It has no effect on received packets. This value normally comes into effect only when you do not do enter/return at the right edge of the screen!

MAX[frame] sets the number of unsent packets which are allowed to build up in your TNC. When this number is reached, the TNC does not accept any more characters from your terminal until there is room (if Flow is ON, the TNC2 default). MAX[frame] also sets the maximum number of packets which may be send it a continuous block.

RE[try] sets the number of times your TNC will retry to send a packet before it gives up. Once this number of retries have been attempted, a disconnect request is sent. If you have a good path to the station you are talking with, this number can be fairly small (say 4). If the path is poor or the frequency is very busy, it may need increasing. Be aware, however, as your retries increase, it increases congestion and may cause others to increase their RE]try] value! The effect of this death-spiral should be apparent.

CH]eck] sets the connection time-out interval. For TNC2,s the units are 10 seconds. The default value for TNC2 is 30 for 300 seconds or 5 minutes. If there has been no activity for this interval, your TNC sends a query packet to the other station. It retries according to the value for RE[try]. If no response is heard, a disconnect is sent.

MY]call] sets the callsign of your TNC. It is illegal to operate without your call entered into the TNC! The default value is NOCALL for TNC2s. Most nodes and other TNCs will not accept connect requests from NOCALL. If you suddenly find your connect requests being rejected, check your callsign!

Check Chapter 3, section 3.F.7, for a discussion of slot time and persistance.

It is easier to describe these parameters than to advise on proper

settings. TXD]elay] depends primarily on the characteristics of your transmitter. FR[ack], DW[ait], and P[aclen] should be similar for all stations in your area.

4.G.2 TERMINAL PARAMETERS: These parameters set the interaction between the TNC and your terminal. There is a lot of variation in these particular parameters from manufacturer to manufacturer. Fortunately, for most terminal programs, you do not have to change much because the defaults fit pretty well. Furthermore, most terminal programs are now flexible enough so that you can change the terminal configuration to fit the TNC rather than the other way around.

Things you might particularly want to check if you are having problems are AUtolf, AWlen (sets number of data bits in characters), Echo, & PARity.

It is the author's strong opinion that you should use the TNC's default terminal parameters and make the appropriate accomodation in the terminal. See section 4.M for the reason why.

4.G.3 CONVENIENCE PARAMETERS: These include a great variety of things from monitor status to beacons.

Some advice may be appropriate here. If you have a TNC with CWID (morse code identification), TURN IT OFF! The need for CWID has long passed.

Beacons are another touchy subject. If you feel you must beacon, do it as infrequently as you can. For TNC2s, the beacon interval is in units of 10 seconds up to 250 (2500 seconds). 2500 seconds is just over 40 minutes. This interval is not too short! Also, if you must beacon, keep the text short. Otherwise, it just clutters the frequency.

A pair of convenience parameters which the author likes are the TNC2 NEW[mode] and NO[mode]. If NO[mode] is off, the switching between command mode and converse mode is controlled by NEW[mode]; if it is on, switching between between command and converse modes happens only by direct command. I prefer NO[mode] off. NEW[mode] off causes the switch to converse mode from command mode to happen automatically every time a new connect occurs. Also, with NO[mode] off, the TNC stays in converse mode when a disconnect occurs. But with NEW[mode] on, the switch is

automatic going both ways.

The U[sers] command (TNC2) controls how many incoming connections are accepted by your TNC. Until you get some practice with handling several conversations at once, set this value to 1. This way, any multiple conversations must be initiated by you.

4.H MAIL BOXES

Several previous discussions have shown mailbox operation (see sections 3.B and 4.D.2). Here the focus will be on how your own mailbox operates (if you have one) and how to create one of you do not have one.

4.H.1 TNC MAIL BOXES: TNC mailboxes reside within your TNC. They stay operating when your computer is turned off or used for non-packet activities. As previously mentioned concerning SSIDs (section 3.B), there are generally two classes of TNC mailboxes. One is the full-time mailbox and usually has a specific SSID assigned to it. The part-time mailbox uses the same SSID as you use but the mailbox cannot function when you are conversing through the TNC.

With the exception of several newer TNCs with mail-snatch capability (that is, they can automatically connect to your local BBS and retrieve your mail), these TNCs take very little to set them up. The full-time mailboxes need an SSID assigned. You may also be able to set the connect message. In the case of part-time mail-boxes, you must remember to turn it on and off at the appropriate times. The author turns his on when packet operation ends and turns it back off (after checking for new mail) when packet operation resumes.

Some TNCs have specific requirements to permit a mailbox to operate. For example, MFJ 1270/1274 TNCs require *user 1* and the streamswitch set to stream A.

4.H.2 SOFTWARE MAIL BOXES: software mailboxes reside in the terminal program. These range from NET/NOS at the high-end (see Chapter 14 and, in Volume 2, Chapter 25) to the popular LanLink (see Chapter 18 in Volume 2). Mailboxes for BayCom and DigiCom modems fall in this category, also.

Software mailboxes are usually controlled by a script or config file. The

writing of such a file is beyond the scope of this book. If the documentation is not adequate, you will have to rely on experience of other users.

4.H.3 MAKING A MAILBOX: Ok, so you don't have a TNC with a built-in mailbox and you don't want to tie up a computer with one of the terminal programs which has a mailbox in it. What can be done to get the effect of a mailbox? Fortunately, its pretty easy.

The strategy is this: there are flow-control commands which tell your TNC when it can send characters to the terminal. If you tell the TNC to stop sending, it simply stores characters in it memory until you tell it to begin again. This works so long as there are fewer characters to be stored than the capacity of the TNC memory! So, how do you use this?

First, look up in the TNC manual under *XON* and *XOFF*. The character specified by *XOFF* tells the TNC to stop sending. The character specified by *XON* tells the TNC to start sending. For TNC2s, the defaults are XOFF = $13 (control-S) and XON= $11 (control-Q). Assuming that your TNC responds to TNC2 defaults, try the following experiment:

(1) Send XOFF character (control-S) to your TNC. No carriage returns are needed; just send the single character.

(2) Press the enter or return key 3 times. You should not see anything happen on the screen.

(3) Send XON character (control-Q) to your TNC. No carriage returns are needed; just send the single character.

(4) Three command prompts should appear on the screen after step 3. This is because those characters were stored in the TNC and were not released until you told the TNC that it is ok.

If this experiment works, you have a rudimentary mailbox! To use it, compose a CTEXT to be used when you are not present. This is a message which is sent to anybody who connects when CMSG is ON. If CMSG is OFF, no CTEXT is sent to a connecting station. The author has used the following:

```
CTEXT KA7EHK message buffer is open for your use;  please
leave msg
```

When you end packet operation, simply send the following commands to your TNC:

```
cmd: CMSG ON
cmd:  (xoff character)
```

Then, when you resume packet operation, send the following. Note that there are no command prompts (cmd:) because they have been held inside the TNC!

```
CMSG OFF
 (xon character)
```

Anything which the TNC received between the times XOFF was sent and XON was sent will come spilling out onto your computer screen! You now have a very simple mail box! You do need also to remember to leave your radio and TNC on; you computer may be off or devoted to other uses.

4.I THE TNC LIGHT SHOW

Most stand-alone TNCs (with the exception of BayCom and DigiCom which really aren't TNCs) have a number of status lights on their front panel. These lights can provide some very useful indications of the activity of your packet station and of the frequency your radio is tuned to.

4.I.1 POWER: the PWR indicator, if you have one, normally just sits there and glows. But if you are having problems, it is one of the first places to look. If it is not on, then power is missing. Check to see that the power cable for the TNC is still in place and that the main power supply or 115v connect is good. If these check out, then there may be more serious problems.

4.I.2 CON: the CON light, if you have one, indicates that your TNC is connected to another station. It should go on as soon as you see a connected message on the screen; it should go out as soon as you see the disconnected message.

The is a fairly significant but not obvious trap here. If you have a TNC2-clone (or similar), with multiple connect streams, the CON light

shows the connect status of the stream you have currently selected. If there is no connection on that stream, the CON light will go out even though there are connects on other streams.

TNC2s have a command called connect-status (*CS*) which lists the connection status of all the possible connection streams. It also shows which stream is the current one. This helps to resolve how many connections you have and who they are with.

4.I.3 STA: the STA light indicates the status of outgoing packets. It stays lit as long as there is a packet waiting to be sent or one which has been sent but not acknowledged. Again, this light shows the status of the currently selected stream; even though all packets may have been delivered on other connections, it will stay lit if your current stream has an undelivered packet. Likewise, if all packets have been delivered on the current stream, it will go out even if there are undelivered packets on other streams.

4.1.4 PTT: the PTT light (Push To Talk) goes on each time your transmitter is keyed. This is a useful indicator of proper connections between your TNC and transmitter. If the PTT light flashes but there is no transmit indication on the transmitter, there is a problem with the radio-to-TNC cable or connectors.

The PTT light is an indicator which shows when your station is being used as a digipeater. If no connect light is on but the PTT light continues to flash, then your station is being used! It may also flash during a connect request before the actual connect is successful.

4.1.5 DCD: the DCD (Data Carrier Detect) light is very useful. It lights when packets are detected on your frequency. It lights when ANY packets are detected, not just addressed to you. Thus, if it is flashing frequently, the frequency is quite busy.

4.I.6 OTHER TNCs: Other TNCs may have different indicators than the ones discussed above. In particular, the Data Engine has a set which depends entirely on the installed software. They do not necessarily behave the same with JNOS40, G8BPQ, or other software.

Look at the owner's manual for your TNC because these lights can tell you a lot about how your station is operating. It should also be noted that many of the multi-mode TNCs have many more indicators than discussed here; some show the current mode. Familiarise yourself with

these because they can often tell you whats wrong when things are not right.

4.J. The TNC Internal Clock

The internal clock used by TNC2s for time marking (time stamping) has an interesting quirk. The folk-tale goes something like this: The TNC was designed around a particular clock crystal frequency. Baud rates were determined according to this frequency as well as the time clock. The software was all written and units built. It was only then that somebody noticed that a harmonic of the crystal frequency fell so close to one of the standard packet frequencies that it was nearly unusable. The fix for this problem was to tune it down slightly in frequency. There would be no real problem with baud rates because the change needed was quite small. But the change resulted in a clock which looses a few seconds (or more) each day. Thus, standard TNC2 clones need constant resetting of the time.

4.K. Computer-TNC Baud Rates

The real throughput of a TNC depends on the radio baud rate (and other things like DWAIT and retries). The on-screen display certainly looks nicer if there is a faster response between the TNC and the computer screen.

TNC2s permit the computer baud rate to be set as high as 9600 baud. Most users who try this rate discover that characters are lost or garbled. The problem is the integrated circuit which is used to convert between computer logic levels and the voltages required for RS-232. It is an operational amplifier (op-amp) and the one used operates rather slowly. The specific integrated circuit is called a quad op-amp (that is, it contains four op-amps) and is an LM324.

This op-amp may be replaced with a much faster TL084. TL084s are available at many hobby electronics shops where components are sold. Simply unplug the existing device and plug the new one in its place. Note the notch on one end of the original and put in the new one with the same orientation. In a standard TNC2, with the front toward you,

this circuit is near the right side of the circuit board about mid-way back.

4.L. Station Layout

The actual layout of a station is more important than one might realize. This is because there are at least three devices in a packet station which can interfere with each other. The transmitter can interfere with TNC and computer operation. The TNC can interfere with receiver operation (as mentioned in section 4.J). The computer can interfere with receiver operation.

Most of these problems are simplified if the station antenna is well separated from the station (30' or 10 meters is not too little). The worst situation is when you must use a small antenna very close to the TNC and computer. Transmitters can cause computers or TNCs to malfunction, and can cause video displays to wiggle. The author has seen and experienced many problems with antennas as close at 10' or 3 meters to computers and TNCs. This is true whether operating on HF or VHF.

When the antenna must be close to your other equipment (such as an emergency station or a portable one), careful choice of the computer is a must. Flat panel computer displays such as those used with laptop computers tend to be less affected by trans-mitters. Also, some computers are more quiet than others; experience of other hams may be an important guide. You may also need to add filtering capacitors at the TNC on the connector for the TNC-computer cable. Be particularly careful that all metal parts of the transceiver enclosure are connected together electrically. Special metal boxes for transceivers may also be necessary.

4.M. When a TNC Quits

Sooner or later, almost every packet operator comes face-to-face with a TNC which does not respond as it usually does. The author has had to deal with this situation several times. Here are some things which may help.

4.M.1 Why IT Happens: It is actually rather difficult to say in every case why a TNC stops operating. Several of the author's cases seem to be associated with very fast power line drops and recoveries. Others have been quite mysterious.

4.M.2 What Happens: One common effect is that the serial computer link settings get changed in the TNC. If the baud rate is set by switch, this seems pretty unlikely to change. But changes in parity, data bit, and stop bit settings have been observed. Other changes seem somewhat deeper than mere serial settings.

4.M.3. What to Do?: The author's first step has usually been to try to re-establish serial communication between the TNC and the terminal.

Step 1: First, try several *return/enter*. One of three things might happen. You might get no response at all. You might get a cmd: (or perhaps a scrambling of these characters). The TNC may try to send packets (as shown by the PTT indicator). If the latter case is true, the TNC is in CONVERSE mode; try a *^C* to see if the command prompt shows. If you get a cmd: then you are close. If there is no response at all, you need to go on to the next step.

If you get a cmd: or something close to this, try asking the TNC what its parity (*PARity*) is; make certain that your terminal settings are the same. Then change the TNC parity back to what you want it to be first and second, change the terminal program to the same value. Do the same for number of data bits (*AWLEN*). If neither of these work, go on to the next step.

Step 2: Sometimes, what appears to be TNC failure is caused by the TNC being in an unexpected mode. These include KISS or HOST (the latter primarily in AEA or Kantronics TNCs). If your TNC is in either of these modes, it is unlikely that you you will be able to restore operation without resorting to the last step. But you cannot know whether or not this is true, so continue!

Step 3: Another reason for unexpected TNC operation in multi-mode TNCs is caused by the TNC being placed into a communications mode (RTTY, CW, AMTOR, etc) which is different than the one you expect. If you have a multi-mode TNC, check with your manual about switching between communication modes. If your TNC is not multi-mode or if you are not successful, continue to the next step.

Step 4: Try typing *RESTART* even if you get no other response on the screen. Returns the TNC to the same condition as if it were being turned on. If the faulty operation is due to a parameter (which is normally stored in the battery-backed memory) being changed, you may see no improvement. But, then again, sometimes it works.

Step 5: Try turning off your TNC, then turn it back on. Again, there may be several responses. You may get the normal start-up message and all will be more-or-less normal. If this is the case, you may need to reset *MYCALL* and any other changes from default operation. The author keeps a card which lists these changes in the front of the TNC manual.

You may get the normal startup message with some characters scrambled. In this case, the serial settings of the terminal are different than that of the TNC. Try changing these settings carefully, one at a time, until the message appears normal, then check to see whether other settings need to be changed.

You may not get any response at all. If this is the case, go to the next step.

Step 6: If you get no recognizable response when you turn on your TNC, something is improperly stored in the TNC's memory. The memory needs to be cleared of all of its old information so it can be restarted as if new. In a normally operating TNC, the *RESET* command will do this. Try typing out *RESET* because if the TNC recognizes it, it will save doing the next step. If it is successful, you will see the standard startup message. If it is not successful, proceed to the next step.

Step 7: To clear the TNC memory, you need to understand that the TNC normally has a small battery in it to provide power for the memory when external power is turned off. You need to disrupt the battery power for a few minutes in order to clear the memory. Some TNCs (such as AEA PK-232s) have a jumper which forms a simple switch; this jumper can be removed to disrupt battery power; check with your manual to determine whether or not your TNC comes this way. Other TNCs have no jumper (as in MFJ 1270/1274). In this case, you need to break the circuit from the battery. These TNCs usually have a simple holder for the battery; you can slide a piece of paper under one of the battery spring clips to break the circuit.

When the battery is disconnected, turn off the TNC and wait several minutes. Reconnect the battery and turn on the TNC. Normal operation should be restored. You will have to reset *MYCALL* and any other non-default TNC settings.

Packet servers are special stations which you can connect to. These stations provide a "service". Some of these services are very simple and some are quite complex. This chapter discusses some of the more common servers and the basics of using them. Nodes, bulletin boards, and DX spotting are discussed in more detail in later chapters. Nodes and bulletin boards are discussed in great detail in Volume 2.

5.A NODES

5.A.1 MAKING A CONNECTION: A node is a station to which you can connect and ask it to connect you, in turn, to another station. In our telephone analogy, this service is like the old-time telephone operator. You rang the operator and asked to ring a telephone somewhere else. After the phone at the other end is answered, the central office becomes transparent. Even if the other phone is only a few blocks away, the signals go from your phone to the central office, and on to the other phone.

A node works much the same way. You connect to a node and tell it: "Connect me to N7AAA." Once the connect is made, the node becomes transparent and you no longer talk to the node; instead, you talk to the other station. An example of this process is:

```
cmd: c valley
cmd:*** CONNECTED to VALLEY
c w7exh
VALLEY:N7FGF-3}  Failure with W7EXH
c n7fgf
VALLEY:N7FGF-3}  Connected to N7FGF
[AEA PK-88]  19096 free  (A,B,H,J,K,L,R,S,V,?) >
cmd: d
cmd:*** DISCONNECTED
```

In this example, the local node "VALLEY" is connected to on lines 1 & 2. Then, the node is asked to make a connection to W7EXH (line 3). The node tries a number of times and fails. Then, it notifies you that it was unable to satisfy your request (line 4). At this point, you are still

connected to the node. A second request was made, this time to N7FGF; it was successful, but only got a mailbox. Finally, a disconnect was made as in the earlier examples.

It is important to note that some users, particularly "old-timers" refer to nodes as "digis". Most nodes will serve as a digipeater but they also do much more. In this book, nodes are called nodes.

5.A.2 AUTOROUTING: Many, but not all, nodes offer autorouting to other nodes. This function is rather like a primitive long distance phone call. Though the old-time phone system did not work exactly this way, it was close enough to pretend. Suppose that you wanted to call your Uncle Henry in New York City. You ring your local phone operator and say: "please connect me to the operator in New York City". After a substantial wait (while operators along the way make the necessary connections), you get the distant operator. Then you are able to say to the New York operator "Please ring Henry Jones at 4435 for me." You did not need to know how the telephone company lines are laid out; the operators manage that detail for you.

Autorouting works much the same way. In this case, suppose that your friend N7AAA is on a (not too distant) node called PODUNK while you can directly connect to a node named METRO. After connecting to METRO, you simply tell it "Connect me to PODUNK". Once that happens, you are connected to PODUNK and you tell IT, "Connect me to N7AAA". It should be fairly obvious that you must know which node N7AAA is using. An example of how this works follows:

```
cmd: c salem
cmd:*** CONNECTED to SALEM
Welcome to the Salem Packet Switch
Type ? for list of available commands.
c mthood
SALEM:AF7S-1}  Connected to MTHOOD:KB7DBD-1
c n7cpa
MTHOOD:KB7DBD-1}  Connected to N7CPA
HI, TYPE <CTRL-T> FOR MENU, TYPE COMMAND "T" TO TALK TO
N7CPA
[ZCZ] *** LAN-LINK 2.00R>
cmd: d
cmd:*** DISCONNECTED
```

In this example, a connection is made to the local node named "SALEM" in lines 1 &2. Then, the node is asked to connect to the node "MTHOOD" (line 5). SALEM notifies when it is successful in line 6. At

this point, SALEM is transparent, and anything typed goes to MTHOOD. Next, MTHOOD is asked to connect to N7CPA in line 7. This is successful with the connect message shown. Finally, a disconnect is done.

It is important to note that you do not need to know how the "network" is arranged between SALEM and MTHOOD. In fact, there is a 70cm link from SALEM to PDX7, a 1.25M link from PDX7 to WLINN, and a 70cm link from WLINN to MTHOOD. But your packet is routed automatically.

It is also important to note that not all nodes handle connect requests in exactly this way. Refer Chapters 8 & 9 for more information.

5.B BULLETIN BOARDS

Bulletin boards don't seem to have a direct analogy in the telephone system we have been using as an example. But if you have ever seen a bulletin board at a community location with cards, for sale ads, etc, you have seen something quite similar.

Most (but not all) of the bulletin boards we are interested in are called "store-and-foreward" BBSs. This means that you may leave a message for a person somewhere else (even non-hams!); the message will be moved between neighboring bulletin boards to its destination.

There are quite a variety of bulletin boards now in operation. Chapter 6 discuss bulletin boards in more detail and Volume 2, Chapter 25 gives you operating details of each type I can find in use in the Northwest. There should be enough in this section to get you started.

To use a bulletin board, you need to know four things: (1)which one to use, (2) how to reach it, (3) how to log on the first time, (4) how the basic operations work.

5.A.1 FINDING A BBS: You can find out which one to use several ways. You can ask other packeteers on the node you prefer to use. You can look at the prompt list on your node to see if it has a "BBS server" attached. To get this, send the node a "?" (after connecting first, of course). A node with an attached BBS will return a prompt line something like this:

```
c wlinn
SALEM:AF7S-1}  Connected to WLINN:W0RLI-1
?
WLINN:W0RLI-1}  BBS RT QTH CONNECT BYE INFO NODES PORTS
ROUTES USERS MHEARD
```

The presence of the "BBS" in the prompt line shows that there is a BBS attached to the node.

Many BBS's have their own "node names". The BBS attached to the WLINN node in the example above has the name "RLIMB" (interpretation: W0RLI's MailBox). A node will give you a list of the other nodes it "knows" about if you send it an *"N"* (for Nodes). Names such as "xxxMB", "MBxxx", "xxxBOX, "BBSxxx", or "xxxBBS" are usually bulletin boards.

Intelligent use of the network suggests that you use the BBS which is the closest to your "home" node, in the network sense. It makes little sense to use a BBS which is 4 or 5 nodes away when there is one 2 nodes away. The closer one usually has all the same bulletins on it. The BBS occupied the network getting those bulletins to it and you don't need to repeat what has already been done.

If you cannot tell which is the closer BBS, ask a local node user.

5.B.2 CONNECTING TO A BBS: Having chosen a BBS for a first try, how do you connect? From a network node, you may tell the node to connect you to a named BBS. You may also connect to a node with an attached BBS and type *"BBS"*; the node will transfer you to the BBS. Some BBSs are not networking and must be connect to by callsign directly from its node.

5.B.3 FIRST TIME LOGON: As a first time user, you will be asked a standard set of questions when you connect (log on) to the BBS. An example of what you will encounter is the following (edited slightly for brevity):

```
CLARK:N7CHR-1}  Connected to RFBBS:AA7RF
[MSYS-1.13-H$]
Hello ?, Welcome to AA7RF's MSYS BBS in Woodland, WA
Welcome! As a new user you will see this information. Next
time you connect you will go directly to the BBS command
prompt. Please register as requested below. The home bbs
you give must NOT be a personal (built into a TNC) BBS but
```

```
rather a well known full service bbs that does mail
forwarding. If you haven't picked a home bbs yet, you are
welcome to use this one. Just enter its call with the NH
command.

Please use N command to enter your name
Please use NQ command to enter your QTH (City and state)
Please use NZ command to enter your Zip or Postal Code
Please use NH command to enter call of BBS you want your
mail sent to
Enter command: A,B,C,D,G,H,I,J,K,L,M,N,P,R,S,T,U,V,W,X,?,*
>
```

Once you respond to these questions, you will be spared this first log-in ritual. The first-time logon procedure varies a little among various BBS types. Follow the instructions closely because they are intended for a first-time user.

5.B.4 BBS BASIC SERVICES: Among all of the services which a bulletin board supplies, the most commonly used ones are (1) reading bulletins, (2) reading personal messages, and (3) sending personal messages.

In most BBSs, an *L[ist]* will give you a list of all of the bulletins which have arrived at the BBS since you last checked in. With your first checkin, this list could be VERY long. Unless you specify otherwise (again, see Chapter 6 and Volume 2, Chapter 25), many BBSs will give you this list about 20 lines at a time. In this context, a "bulletin" is a message which can be read by anybody.

If you find a bulletin with a subject which is interesting, note the message number (usually near the left end of the line in the message list). At the BBS prompt line, you may enter *R[ead] ###* to read the message with number "###".

Most BBSs notify you when you logon if you have waiting personal mail. If you are uncertain about your "mail", an *LM* (List Mine) will give you a list of all your mail. Your personal mail is numbered like the bulletins. And, like bulletins, you may read your mail with *R[ead]###* at the BBS prompt; *RM* (Read Mine) will also read all personal messages addressed to you which you have not already read.

It is your responsibility to dispose of your mail after it has been read. To do so, send *K[ill] ###* (Kill message ###).

Many BBSs do not "remember" what you have read unless you disconnect by sending *"B"* (Bye) to the BBS.

5.C CONVERSE SERVERS

Converse servers are another answer to the question: "How do I find someone to talk to?" This is a little like a party line where everyone on the line is listening and anything said by any of the listeners is heard by all others.

Converse servers have several names. One is "Round-Table", another is "CHAT node", a third is "CROWD node" . They come in several styles which are both similar and different.

5.C.1 HOW CONVERSE SERVERS WORK: All of the servers provide a way where two or more packet stations can carry on a conversation. When you connect to it or otherwise activate it, all you type is sent to all other stations which are similarly connected. Depending on the implementation, you may direct comments to a particular participant. It is also often possible to specify information about your-self (such as name and QTH); this information is available to the other participants.

5.C.2 AN EXAMPLE:

```
SALEM:AF7S-1}  Connected to WLINN:W0RLI-1
rt
WLINN:W0RLI-1}  Connected to RT

W0RLI RoundTable Server V3.0
Copyright (C) H. N. Oredson 1992
Type /H for command summary.
KA7EHK : *** Joined the RoundTable
/H
/U - Users
/N - Enter Name
/Q - Enter qth
/B - Leave RoundTable and return to node.

/Q Tangent, OR
*** Done
/N Jim
*** Done
```

```
/u
Stations in the RoundTable are:
 2 KA7EHK [Jim, Tangent, OR]
/B
Returned to Node WLINN:W0RLI-1
```

This example is from one of several servers in the Portland, Oregon area. This one is entered by typing *RT* while connected to the node (line 2). When you have connected to the server, there is a "log-on message" which notifies you of the fact (lines 3 to 8). It also tells you how to get help. One of the common convention with these servers is that a line preceded by a / is directed to the server, rather than to the conversants. In the example, a name (line x) and QTH (line y) is specified. When asked who the current participants are (with */u* near the end of the session), it indicates the call(s) (KA7EHK was the only participant this time), plus name and QTH if entered. Notice, also, that when you terminate the server with a */B* (bye), you are left still connected to the node to which the server is attached (in this case).

5.C.3 CONVERSE SERVER TYPES: There are 4 major converse server implementations. One (shown in the preceding example) is attached to certain nodes much like a BBS. You can determine whether or not there is such a server just like you can find if there is an attached BBS: send an ? to the node in order to get a prompt from the node. If you see "RT" on that list, there is one and you need only type RT to connect. An example of such a prompt line is this one:

```
WLINN:W0RLI-1}  BBS RT QTH CONNECT BYE INFO NODES PORTS
ROUTES USERS MHEARD
```

A second server type is the "CHAT node" or "CROWD node". This type appears as a node to the packet network. With this type, most are named "CHAT". You must connect to it as if it were a node. Once done, it behaves much like the other converse servers. See Volume 2, Chapter 24, for a more detailed description of this combination node and converse server.

Both of the preceding converse servers could be considered "local conversation". This is because servers are isolated from each other. The following two types are "distributed conversation" because servers may be linked together.

DX Cluster stations usually contain a converse server. See section 5.F for an introduction to DX Spotting and Chapter 7 for a detailed description. It should suffice to say at this point that, except for command details, the operation is similar to that previously described. The principle difference is that users of linked DX Cluster stations can talk to each other as if they were all using a single server.

NOS stations (including JNOS) have the capacity to implement a distributed converse system. The extreme case of this is the converse arrangement over Internet in which stations in Australia, Eastern Canada, Europe, and a number of U.S. sites can all talk together as if on a single server. See 14.J for some notes about NET and NOS; see Volume 2, Chapter 24, for details.

5.D CALLBOOK SERVERS

Callbook servers are a way of finding out basic information about the holders of U.S. amateur radio licenses. There are two styles of callbook servers which are available in the Northwest. One is the local server in which the information is available on a compact disk (CD) at the node site. This type can be found by, again, observing the node's prompt line:

```
WLINN:W0RLI-1}  BBS RT QTH CONNECT BYE INFO
  NODES PORTS ROUTES USERS MHEARD
qth ka7ehk

JAMES D WAGNER  KA7EHK
31677 N LAKE CREEK DR
TANGENT, OR 97389
Born: 41  Class: T

Returned to Node WLINN:W0RLI-1
```

With this type, one simply types *"QTH callsign"* as in line 3. The result is returned on several lines.

Please be aware that these CDs are expensive and the station operator may not always purchase a new one every time one is available. Also be aware that these servers (usually) only list U.S. hams; some DX Spotting Systems have available U.S, Canadian, and some foreign calls.

Many callbook servers also do other things like search for calls associated with a given name, or associated with a ZIP code. Ask the

SYSOP for details if you want to use these other features.

There is also the Internet callbook server. Through Internet Gateways, one may access a server on the U.S. East Coast. Ask the sysop of your local Internet Gateway for details.

5.E INTERNET GATEWAYS

Internet is an international computer network. It was originally designed to link major universities and government research laboratories. In recent years, the network has grown to include most universities and many "high-tech" businesses. Most universities with university-wide computer networks have "internets" on the campus with those nets linked to "the Internet".

The KA9Q "NOS" program and its derivatives (including JNOS) provide a means for joining the packet radio network and various internets. When such an arrangement is made, the result is referred to as a "gateway". For detailed information about how this works, see Chapter 14 and the JNOS entry in Volume 2, Chapter 24.

5.F DX SPOTTING

DX Spotting or "DX Clusters" are a special purpose packet network (at least, in the Northwest). These are nodes which are controlled by special software. The nodes are linked together so that most of what happens at each individual site is sent to all of the others.

The purpose of this system is the location of DX stations. The features are specifically designed with this in mind. The new user should be aware that although these stations accept messages in the style of a store-and-foreward BBS, there is generally no interchange between the DX cluster system and the "regular" packet system in the Northwest. See Chapter 7 for details.

5.G SUMMARY

In this chapter, a variety of services provided by various packet installations have been discussed. The intention for this chapter was to provide enough information for new users so that there would be awareness of features of the packet radio system.

For more information, refer to Chapter 6 about bulletin boards, Chapter 7 about DX spotting nodes, Chapter 8, 9 & 10 about packet networking, Chapter 11 about the inner workings of packet protocols, Chapter 12 about H.F. operation, Chapter 13 about packet satellites, Chapter 14 about file transfers, & Chapter 15 about TCP/IP.

Chapter 6 BULLETIN BOARDS

Bulletin boards (BBSs) have become almost ubiquitous in our packet system. In this chapter, we will look at the basic method in which these operate. We will concentrate on the "store-and-forward" BBS; TNC "mailboxes", automatic mail programs such as LanLink, and DX spotting systems are discussed elsewhere.

While bulletin boards have become widespread, not all packeteers are enthusiastic about them; in some cases, the feelings are very negative. The cause and effect of this situation will also be considered in this chapter.

At the present time, all bulletin boards are full computers. Because of economic considerations, it does not seem practical to build a special purpose "bulletin board machine". Also, due to the human supervision generally required, it does not appear practical at the present time to locate a BBS on a remote hilltop.

Where BBS commands are discussed, there are often two forms, a short and long form. Usually, the short form is made up of the first few characters of the long form. If the long form is used, it must be entered exactly, in full. These commands will be shown as *XX[yyy]* where *XX* is the short form and *yyy* are the optional additional characters to make the long form. Thus, the command *L[ist]* could be entered either as *LIST* or *L* . Usually upper-case and lower-case characters are interchangable.

6.A HOW A BULLETIN BOARD WORKS

The primary use of bulletin boards is the receipt, movement, and delivery of messages and bulletins. We will use the term message to indicate something addressed to a specific individual; bulletin refers to something which can be read by anyone. Some other services may be provided but these represent the core function of a BBS.

Every message deposited at a BBS with a *S[end]* or *SP* (Send Personal) is given a reference number. You specify to whom the message is to be sent by callsign. The BBS uses your callsign to indicate who sent the

message. The BBS also attaches its call (and other information) to show where the message originated.

Every time you log onto a BBS, the program reads through all of the messages. If it finds any addressed to you which have not been previously read, it notifies you. If there is no notification, then there are no unread messages.

When a message is addressed to a user of the same BBS, the message remains for a time set by the BBS operator (SYSOP). If the message has not been read by that time, it may be erased.

6.A.1 HIERARCHICAL ADDRESSING: When a message is addressed to somebody at another BBS, part of the addressing includes both the BBS callsign and its hierarchical address. The address includes the state, the country, and the continent. In this form, one of the Portland, Oregon-area BBSs might be specified as KB7DBD.OR.USA.NA.

The first part of the address is the two character abbreviation for state or province. In the US, the two letter postal state abbreviation is used. There is a separator (a period), followed by the country designator. The most common designators for those of us in North America are CAN (Canada), MEX (Mexico), and USA (United States). There is one more period separator followed by the continent designator. This is needed because there are duplicate country abbreviations on several continents (such as AUS for Austria and Australia).

Some large states or states with many bulletin boards use additional address elements. For example, with California BBSs, there are addresses such as "N6AA.#NOCAL.CA.USA.NA". The letters preceded by the pound-sign (#) are commonly used as a regional designator with a state; sometimes it designates the nearest network node.

6.A.2 LOCAL MESSAGE FORWARDING: Once a message has an address, how does it move? Bulletin boards automatically connect to each other through the packet network. If the destination is a BBS which is normally in direct contact with the one where it was sent, your BBS simply says to the other one (in effect) "I have a message for you. Can you accept it?" If the answer is "yes", it is transferred. The only difference between this message and one which stayed at the BBS is a forwarding record which shows where the message went.

6.A.3 DISTANT FORWARDING: But what if the message is for a BBS

which is not in direct contact with the one where the message originated? The SYSOP must create a forwarding file which tells which of its neighbors are sent messages for various destinations. For example, on the West Coast, a neighbor which does HF forwarding might be sent all messages for states east of the Mississippi River. The BBS simply scans its forwarding file and, (usually) based on the state designator in the hierarchical address, hands the message off to the appropriate neighbor. Thus, a BBS in Washington need not know the precise location of a BBS in North Carolina; it simply sends the message in the (hopefully appropriate) direction until it is close enough to be delivered.

Each BBS though which the message passes adds its signature to the forwarding record attached to the message. This record tells where the message went and when.

6.B MESSAGES

As previously indicated, a message is something addressed to a specific individual. Lets look at the basics of message handling in somewhat more detail than in Chapter 5.

6.B.1 LOG-ON NOTIFICATION: Every time you log onto a BBS, the program compares your call with the address of messages it holds. If there are any which you have not yet read, it notifies you. In general this notification looks something like this:

```
SALEM:AF7S-1}  Connected to SRABBS:N7IFJ
[MSYS-1.12-H$]
Hello Jim, Welcome to N7IFJ's MSYS BBS in Salem, OR

You have unread mail, please kill when read:
MSG # TR  SIZE TO     FROM   @BBS   DATE    TITLE
 8559 PN   380 KA7EHK KB7IVK   ---  930225 RE: Guide
Enter command: A,B,C,D,G,H,I,J,K,L,M,N,P,R,S,T,U,V,W,X,?,*
>
```

Observe the elements of this notification. The first item is the message number. Next comes message type; in this case PN means that it is a personal message which has not yet been read. The type becomes PY after being read. The next item is size in characters. Then comes the callsign of the person to whom the message is addressed. Following that is the callsign of the person who sent the message. Depending on

the BBS style, the @BBS item may or may not show something here; in this case, there is an entry only if the message has not yet arrived at its destination. The date may be either the date it arrived at the destination or the date it was mailed. The final item is the subject as provided by the person who wrote the message. The format of this information may differ among BBS styles but, in general, all contain about the same information.

6.B.2 READING MESSAGES: With almost all BBSs, *R[ead] ####* (where #### is a number) will provide you with the text of the message of the number you specified. You will not be able to read messages addressed to others. Most BBSs allow you to read several messages in one "batch". The usual format is *R[ead] ###1 ###2 ###3* (where ###1 is the number of the first message, etc.) I usually limit such batches to 4 messages or so if they are not too large (say 1000 characters or fewer).

Many BBSs accept the command *RM[ine]* (ReadMine). This command usually gives you the text of all unread messages addressed to you.

6.B.3 LISTING MESSAGES: Almost all BBSs recognize *LM [ine]* (ListMine) as the command to list all messages addressed to you, whether you have read them or not. In some cases, this list also includes messages you have sent. This list does not give you message text, only the basic information about the message.

6.B.4 KILLING MESSAGES: Again, with almost all BBSs, *K[ill] ####* will kill (erase) message number ####. You cannot kill a message which you did not send or was not addressed to you. Unless there is a definite reason not to do so, please kill messages after you read them. They occupy disk space on the BBS computer and will stay there until the SYSOP's time limit runs out.

6.B.5 VERBOSE READ: If you are interested in how a message arrived at your BBS, try a verbose read. In some programs, the command is *RH ####* (ReadHeaders) and in others, *V ####* (Verbose) This gives you the message with the forwarding log. Here is an example:

```
rh 8629
MSG # TR  SIZE TO     FROM   @BBS   DATE    TITLE
 8629 PN  1125 KA7EHK N7HYD  ---    930227 CALLBOOK
R:930227/0636z @:N7IFJ.#SALEM.OR.USA.NA Salem, OR
R:930227/0339 3903@W0RLI.OR.USA.NA
```

```
R:930228/0306 3289@N7CHR.#VANC.WA.USA.NA
R:930223/0447 0@N7UVH.#INW.ID.USA.NA
R:930222/0637 8218@N7KQB.#INW.ID.USA.NA
```

This message originated at the N7KQB BBS in Idaho & was handed off the next day to the N7UVH BBS in Idaho. Three days later, it was handed to the N7CHR BBS in Vancouver, WA. From there, it went to the W0RLI BBS in Oregon and from there to the N7IFJ (destination) BBS in Salem, Oregon.

6.B.6 AUTOMATIC REPLY: A recent addition to many BBS programs is the automatic reply feature. It copies the sender information from the message you specify. The program addresses a message from you back to that sender. In this way, you avoid errors in copying this information. The command varies with BBS. With some it is *REPL ####* to send a reply to message ####; with others it is *SR ####* (SendReply).

6.B.7 HELP: All BBSs that I am aware of have some kind of help method. Almost universally, the *?* tells you how to get help; *H* also usually works. In some cases *H xxx* (where xxx is the command you want to find out about) will tell you about that command. In other cases, it is *?xxx*. The prompt line usually gives you a list of all of the basic commands which the program accepts.

6.C BULLETINS

Bulletins were previously defined as a message which can be read by any user of a BBS.

6.C.1 LISTING BULLETINS: In general, the *L[ist]* command will list all of the bulletins which you have not read. Here is a common example of such a listing:

```
L
MSG # TR  SIZE TO     FROM   @BBS   DATE    TITLE
 9412 B$   871 SALE   KD7H   PNW    930303 TEN TEC SALE
 9411 B$   630 ALL    KB7PLE PNW    930303 SALE, ALINCO  DJ160
 9407 B$  1422 ALL    EB5BUF WW     930303 IMFORMATION...?
 9404 B$  4329 AMSAT  GM4IHJ WW     930303 Satgen205 SUN AND RADIO
COMMS
 9403 B$  2767 SALE   AA6ED  PNW    930303 SALE: Sanyo 555 Computer
 9402 B$  1436 QST    KT7H   ARRL   930303 ARLB022 FCC call sign
update
 9401 B$   605 WANT   KB6YZD ALLUSA 930303 Want Collins 75A4
```

```
 9400 B$   883 SALE   N6WMK  ALLUSA 930303 KENWOOD 440SAT, PS-50,
SP-430
 9399 B$   672 WANT   KA9UMJ ALLUSA 930303 Heath HW24 mobile mods
wanted
 9398 B$   650 SALE   KV6I   ALLUSA 930303 ARGO 509+PWR SUPPLY+CW
FILTER
 9397 B$   555 WANT   KV6I   ALLUSA 930303 BOONTON 260A Q METER
 9396 B$  1068 HELP   N9MXT  ALLUSA 930303 Info On 10meter Mobile
Help
 9395 B$   800 ALL    KF9AQ  ALLUSA 930303 Need schem Motorola G41LLB
 9394 B$   748 WANT   WE6A   ALLUSA 930303 INFO & N.B. FOR ALDA 103
 9393 B$  1274 BINARY WD6EHR ALLUSA 930303 Binary files for ALL p1/4
```

The listing shown here is but a small fraction of the actual list which was obtained. If it several days has passed since the last listing, it may be very long!

Note that the information in this listing is very much like that contained in the message notification (see 6.B.1). There are two distinct differences. The first is under the type; here you see B$ which indicates that it is a bulletin. The second is in the TO column. This item is used to very roughly categorize the bulletin. The third is in the @BBS column. For bulletins, this item is used to specify distribution. This item is specified by the person who sent the bulletin. You should note that these vary from PNW to ALLUSA to WW (World Wide!).

6.C.2 READING BULLETINS: The method is exactly like reading messages except that ***RM*** does not apply here.

6.C.3 REPLYING TO BULLETINS: You may use the same automatic reply method which is used for personal messages. See section 6.B.6 for more information.

6.C.4 SENDING BULLETINS: Bulletins are sent just like messages except that you generally use ***SB*** to denote a bulletin. Instead of the callsign address for personal messages, pick a 6 character category it might fall in. Read bulletin lists to observe what sort of categories are being used. Instead of the destination BBS call, the entry should be a distribution category; if you don't put anything here, it will stay on the BBS where it is sent.

PLEASE! Use the smallest distribution which makes sense for your message. Please read section 6.F.1, below, about bulletin addressing!

For subject, try to choose a concise entry of about 35 or fewer characters including spaces. People decide whether or not to read a

bulletin largely based on this. If it makes no sense, it won't be read!

Keep the text of your bulletins concise. If you can keep it fewer than 1000 characters (12 lines, 80 characters long), you will get more readers and fewer objections to its presence.

6.D NTS TRAFFIC

NTS refers to the National Traffic System, a arm of the American Radio Relay League (ARRL). One of the major NTS activities is the movement of third-party traffic. While much of this is done by CW and voice, digital modes including packet serve well.

Because of the relative slowness of BBS forwarding, (when compared to some of the other traffic methods), packet is generally not used for relatively urgent messages. But packet does particularly well with lists which might be confusing in some other modes.

You do not need to be an NTS person to originate or deliver NTS messages. Lets look at delivery first, then origination.

6.D.1 DELIVERING NTS PACKET MESSAGES: These messages are not listed among bulletins. You must ask for a list. On most BBSs, *LT* lists traffic. The result (which should not be a surprise) looks a lot like lists of personal messages and bulletins:

```
MSG # TR SIZE TO    FROM  @BBS   DATE    TITLE
 9412 PT 871 97389 KD7H   NTSOR 930303 503-928-TANGENT
 9411 PT 630 97301 KB7PLE NTSOR 930303 503-233-SALEM
```

While the form should look familiar, what's in it is quite different. The entry under TO is the postal ZIP code of the addressee. The entry under @BBS is the NTS state designation; the two letter postal state abbreviation attached to NTS is used. The last part under title gives the telephone area code and telephone prefix. The latter is not required and not all messages will have it but it does make it easier to tell if the number is one you can call without a toll charge.

If you decide that it is one which you want to try to deliver, try *R ####;* if the BBS won't do it, try *RT ####* (ReadTraffic message number) to read it. The message should follow the NTS message format which you

will find in Chapter 23, (Volume 2). Try to deliver it quickly. When you are successful, go back to the BBS and *KT ####* (KillTraffic message number) to erase it. If you don't, somebody else may try to deliver the same message.

6.D.2 ORIGINATING NTS PACKET MESSAGES: Originating a third-party message is just the reverse of delivering one. Use:

ST ZZZZ @NTSxx

where: ZZZZ is the postal ZIP code and xx is the two letter state abbreviation.

When subject is requested, try to include the telephone & town information as shown in the previous section.

For the text of the message, follow the standard NTS message format which is shown in Chapter 23, (Volume 2).

6.E WHITEPAGES

The WhitePages are an attempt to automatically route messages to individuals. When you log-on to a BBS for the first time (see Section 5.B.3), the information which you enter may be sent to a regional WhitePages server. This server attempts to keep a listing (much like the telephone directory white pages). The results are distributed regularly to other BBSs in the area covered by this server.

In general, the WhitePages process works well. There is, however, a rather drastic flaw in it. Suppose that you travel and take your packet equipment with you (yes, there are folks who do!) Suppose that your home BBS is in Seattle and you are in Chicago. You send a message to a friend back home. The person who receives the message attempts to answer you. But where does the message go? It goes where the WhitePages listing says you are supposed to be, not where you are.

At present, there appears that little can be done about this in areas where this system is used other than to notify the normal home-BBS sysop of the new (temporary) location. Just don't be surprised if it happens to you or a friend.

6.F COMMON CUSTOMS

Most of the customs issues on bulletin boards concern bulletins. But whether message or bulletin, both are forms of amateur radio communication and fall within the regulatory limits set by the FCC.

6.F.1 BULLETIN ADDRESSING: One of the most misused activities on BBSs is the ALL@USA or SALE@USA bulletins. Please think before you address a bulletin. Is it really important that it be distributed all over the country? There certainly some issues and items which warrant such addressing, but most do not! It may take several days or more for a bulletin to travel from one coast to another; most FOR SALE items are probably sold by the time the notice reaches the opposite coast. The resulting bulletins are just so much "trash" on the BBS!

6.F.2 LIMITED BULLETIN ADDRESSES: There are bulletin addresses which are far more limited in scope that "@USA". You can use "@USW" for the Western U.S. You can use "@PNW" for the Pacific Northwest. You can use "@ALLOR" for the state of Oregon (and there are similar designators for other states). There are even more localized addresses like "@PDX" (for Portland-area); again, there are probably similar designators in other metropolitan areas. Check with the SYSOP for these designators if you have any questions.

6.F.3. OTHER CONSIDERATIONS: Some BBSs do not welcome for sale items. Please observe or ask if you have any questions.

There are often other local "customary practices". Talk to others. If there is a problem with the customary practice, find out what is common with other BBSs in your area. If you don't like it, use another BBS. If you feel strongly about it, prepare a well-thought and persuasive argument... and use the bulletin process to present it to other users in your immediate area (but not to ALL@USA !!).

6.G THE BBS & THE PACKET NETWORK

After getting past the issue of ALL@USA and SALE@USA bulletins, the next most commonly voiced complaint is "how BBSs hurt our network!" Let's look at this concern and see how valid it is.

It is not uncommon for a BBS with reasonable access to other BBSs

which move regional bulletins to handle in excess of 100 bulletins per day. One observation suggests that bulletin sizes of about 1000 characters may be about average. Depending on the local node parameters, such a bulletin would take 8 packets of 125 message characters (and another 50 header characters per packet). At 1200 baud, each packet occupies the network for 0.5 seconds or more, again depending on node parameters. In addition, there is transmitter key-up time ahead of the packet. With modern transceivers, this might be 0.3seconds; with older, 0.5 seconds (see sections 3.F.3 and 4.G.1 for about DWait). Lets be charitable, then, and say that a packet takes about 0.8 seconds, recognizing that it may be considerably longer. A short packet is required to ACK (acknowledge) each packet and make take another 0.05 to 0.1 seconds (plus DWAIT of 0.3 to 0.5 seconds). With zero retries, the 8 packets would thus occupy one link of the network for about 8.8 seconds. Packets, of course, are not sent without wait time between them so the actual time is again a little longer. Thus, our hypothetical 100 bulletins will take up 880 seconds or 14.7 minutes for each section of the network through which they pass. If the BBS forwards every bulletin received, that BBS is occupying the local network for about 30 minutes per day with bulletins.

Now, if a BBS did not have to share the network with other users, 30 minutes per day of "network loading" per day on account of bulletins is pretty small. But this is actually an unrealistically small value.

Suppose that the local network is congested. Suppose that there are hidden transmitter nodes in portions of this network (See Chapters 8 & 9 for discussions about networking). Then the retry rate goes up. It may go way up. If the network is congested and packets takes an average of 4 tries to get through, 30 minutes becomes 2 hours. If the number of bulletins is larger, the loading time goes up also. And this still does not include message forwarding.

If a BBS forwards during "prime time" (about 5PM local to about 8PM local), the impact is quite obvious. As a result, most BBSs schedule forwarding for off-peak times (especially Midnight to 6AM, local).

This discussion, as sketchy as it is, should show the source of the conflict. Users get disconnected when a BBS hogs an inadequate network. There are at least three commonly used solutions to this problem.

One solution is to fix the network. The view of some (including the

author) is that if the network cannot support BBS forwarding, it is ill equipped to support other operations which also stress the network (such as emergencies). In this view, networks should be restructured so that there are only a few nodes on each frequency. The commonly stated guideline to maximize the capability of such networks is: no packet should leave a node on the same frequency as it came in on. This way, the retry rate is drastically reduced, the throughput goes up, and everybody is happier.

Another solution is to increase the network baud rate. This solution also increases the throughput but only so long as links are good, the retry rate is relatively low to begin with, and appropriate equipment is used.

Another solution is to have BBSs exchange packets on different frequencies than the regular network. The extreme version of this is to disallow BBS operation on segments of the network. This is the position taken by some node operators in scattered areas of the country; while the author may disagree with the philosophy behind viewpoint, I respect it. Node users should also. When the node information says no BBS use, please respect that request.

Chapter 7 DX SPOTTING NODES

Section 5.F introduced the basic ideas of a DX spotting node. Examination of the characteristics of the DX nodes shows that each is a collection of servers. There is the core "Spotting Server" which is used to notify participants of DX station activity. In addition to that, there are other servers which carry out various functions. The presence or absence of these other servers depends on the particular software in use and the choice of the SYSOP. The spotting node software used as an example in this chapter is "PacketCluster" from Pavillion Software.

The other servers include antenna azimuth determination for DX destinations, dissemination of propagation forecasts, "mailbox", local time determination at DX destinations, weather reports, data base management and access, callbook lookup, and conference services. While the command "syntax" may not emphasize this "collection of servers" aspect of DX Spotting Nodes, it is, none the less, there and important.

It should also be pointed out that while these nodes are often networked together, a lot of work has been done to hide the fact from users. This is actually quite useful because it makes it easier to use. By and large, the users are folks who simply want to use packet radio as a tool for other interests. Thus, there is no obvious connecting from node to node. If you request callbook information from a server in the system which is not the one you are connected to, it happens whether or not you realize it is a distant node. It may be slower than your local node, but it still happens.

The author's special thanks go to Larry Johnson, K7LJ, for a lot of help on this chapter. Larry is one of the organizers of the "NW DX Spotting System" which extends from Vancouver, British Columbia to Eugene, Oregon.

One of the nodes in the NW DX Spotting system is used as an example for this chapter. DX-ers in other areas should be aware that this system is limited in its coverage. There are isolated (that is, not linked) spotting nodes scattered throughout the country as well as other networked systems. Some of these use the DX spotting facilities which are available in the MSYS node/BBS software; see Chapter 25 of Volume 2 for some more details if this is the case in your area. There may be other spotting software in use. See Chapter 26 (in Volume 2) for an international DX Spotting Node List. That which is shown here appears to be used by all of the nodes in the Oregon-Washington-British Columbia system.

7.A Use OF DX NODES

The usual use of DX nodes is quite different than the normal packet system. Please recognize that this is written from the perspective of a non-user of the DX system! Here, the DX nodes are just another tool for making contacts with HF DX stations.

The common way in which this system is used is that the local DX node is logged onto when HF operation starts. The connection is maintained during operation. Unlike the NetRom system, the DX nodes do not disconnect you after a period of inactivity.

Some special TNC settings may be appropriate. The "Pavillion Software" Spotting Node shown in the following example uses "control-Y" for several purposes. TNC2s use ^Y for the default "CANcel PACket" command character. You can tell if this is the case with TNC2s by sending the TNC *CANP[AC] (enter)*. If it responds with $19 (19 hex), then it is ^Y. If this is the case, you should change your CANPAC. ^A is suggested; again for TNC2s, the command is *CANP[AC] $01* to change it to ^A.

The "Pavillion Software" manual also indicates that your lines should be ended with a carriage return, only. TNC2s have a function *LF[ADD]* which adds a line-feed to each carriage return. Added line-feeds are rarely used now and you should make certain that it is off. Again, for TNC2s, the command is *LF[ADD] OFF.*

When a DX station is reported by one of the users, all others who are connected (throughout the system) are notified. Users may specify that

they wish only to be notified of certain call prefixes or groups of prefixes (called filtering).

If basic terminal software is used, then this information appears on the screen. Many users have special software which compares data on QSL cards already in possession. Using this software, if a needed country is reported, the terminal program notifies with beeps, flashes, etc. One of the programs which does this is CT, a DX contest logging program.

7.B LOGON

Here is a logon example for N7AVK, the DX node located near Salem, Oregon. The software used by this node is the same as all of the other linked nodes in Western Oregon and Washington. The author had logged on previously and had indicated name, etc. The example is artificially divided, just to make it easier to discuss. The font size used in this text is smaller than normal to get the normal screen width on a printable page.

7.B.1 INITIAL CONNECT: The initial connection goes like this.

```
cmd: *** CONNECTED to N7AVK
Hi Jim!  You've been Digitalized to Mother-Cluster Node N7AVK
ARRL Phone Test this Weekend.. Make a Q..!
Cluster:  4 nodes, 10 local/45 total users Max users 149  Uptime 3 16:58
KA7EHK de N7AVK     5-Mar-1993 0457Z    Type H or ? for help >
```

This logon messages tells you several pieces of information. First, there is the message of the day. This is followed by some very basic cluster information. In this case, there are 4 nodes which are currently linked. There are 10 users on this node and a total of 45 users presently in the system. Max Users appears to be the total number of different calls which have logged in since the node was reset; in this case, the last reset appears to have been 3 days, 16 hours and 58 minutes ago.

7.B.2 NODE COMMANDS: The *h[elp]* command from the node gives this:

```
H
                  PacketCluster (tm) V5.4
            (c) 1986-1992, Pavillion Software

The available PacketCluster commands are:
A,A/F,BYE,CONFER,DE,DI,DI/A,DI/O,DX,SH/DX,H,R,REP,S,S/P,SET,SH,T,TY,UPL,UPD,WWV,SH/
WWV,SH/WX

ANNOUNCE  <A>   - Make a general announcement to local node  <A>
ANNOUNCE  <A/F> - Make a general announcement to all nodes   <A/F>
BYE       <B>   - Bye, disconnect from the PacketCluster     <BYE>
CONFERENCE      - Enter network conference mode              <CONFER>
DELETE    <DE>  - Delete mail message                        <DE MSG#>
DIRECTORY <DI>  - Show active mail messages                  <DI>
DIRECTORY <DI/A> - Show All active mail messages             <DI/A>
DIRECTORY <DI/O> - Show mail to or from yourself             <DI/O>
DX        <DX>  - Make a DX spotting info announcement       <DX FREQ CALL>
LIST      <L>   - Synonym for DIRECTORY                      <L>
Show DX  <SH/DX> - Show a DX spotting announcement           <SH/DX>
HELP or ? <H>   - Help (displays this listing)               <H>
HELP command    - Display help for a particular command     <HELP SHOW>
QUIT      <Q>   - Synonym for BYE                            <Q>
READ      <R>   - Read a mail message                        <R MSG#>
REPLY     <REP> - Reply to the last-read mail message        <REP MSG#>
SEND  <S> <S/P> - Send a private mail message <S CALL>  or  <S/P CALL>
SET       <SET> - Set user-specific parameters     Example: <SET/Name Tim>
SET/BEEP        - Set Bells on or off                       <SET/NOBEEP>
SET/DX          - Set DX announcements       <Default ON> OFF=<SET/NODX>
SET/WWV         - Set WWV announcements      <Default ON> OFF=<SET/NOWWV>
SET/ANN         - Set Announcements          <Default ON> OFF=<SET/NOANN>
SET/MAIL        - Set Mail announcements     <Default ON> OFF=<SET/NOMAIL>
SET/TALK        - Set Talk feature           <Default ON> OFF=<SET/NOTALK>
SET/LOGIN       - Set Login announcements    <Default ON> OFF=<SET/NOLOGIN>
SET/LOGOUT      - Set Logout announcements   <Default ON> OFF=<SET/NOLOGOUT>
SET/FILTER      - Filter any DXCC prefix     <SET/FILTER/CW/BANDS=40,20 JA>
                - Filter command continued   <SET/FILTER/SSB/BANDS=15,10 JA>
SET/NOFILTER    - Clear Filter settings      <SET/NOFILTER/CW/BANDS=40,20 JA>
SHOW   <SH/COM> - Display various PacketCluster Databases   <SH/COMmands>
SH/USERS        - Display local Cluster users/Show all users<SH/USERS/FULL>
SH/TIME Prefix  - Show local times of any DXCC prefix       <SH/TIME YI>
SH/DX freq1 freq2- Display DX between frequency ranges          <SH/DX
14150-14200>
SEND call       - Send a message to a single station        <SEND N6IXX>
SEND call,call  - Send a message to multiple stations  <SEND N6IXX,W6GO,K6LLK>
TALK      <T>   - Talk to specified station                 <T K6LLK>
TYPE      <TY>  - Display a particular file  Example: TY/BULLetin User.cmd
UPDATE    <UPD> - Update a database                         <UPD/Data>
UPLOAD/FILE     - Upload a general file                     <UPL/File>
UPLOAD/BULLETIN - Upload a bulletin file                    <UPL/Bull>
WWV       <WWV> - Make a WWV announcement  <WWV SF=xxx,A=xx,K=xx,Forecast>
WWV    <SH/WWV> - Show a WWV announcement                   <SH/WWV>
WX         <WX> - Make a Weather announcement               <WX>
SHOW WX <SH/WX> - Review recent weather announcements       <SH/WX>
KA7EHK de N7AVK   5-Mar 0459Z >
```

The first column gives a concise name for the command. In many cases, there is a second column with an entry such as <xx>; This is the short-hand command. The large column down the center gives a brief

word description of the command. The last column gives an example of an actual entry.

7.B.3 USERS: The *sh/users/all* command gives you a list of all of the current users of all of the Spotting Nodes (if several are linked). The *sh/users* command simply gives the list of the users on the node to which you are connected. Station calls in parenthesis, that is "( )" have given their node a *set/nohere* command which means that they are connected but not available for conversations. Station calls with a "+" indicates that they are using the conference server.

```
sh/users/all
Stations currently connected to the PacketCluster    Local node: (N7AVK)
   KC7EM  (WR7D)  (AB9O)   W7GUR   W7EYE   WA7UCJ
   W7QK   (N0JO)  (KA0EPR) K7RO    N7BSB   (W7XN)
   W7ZI   AA7EA   K7OZ     K7LJ    WA6SDR  (N7PKB)
   AI7B   AD7L    KB7DA    WB7SRW  (KO7N)  (WJ7S)
   (W7IL) (WJ7R)  (KB7IVU) (K7DBV) NK7L    W7ZR
   WA7EQL N7CWR   WK7Z     K7UN    W7RM    KG7ZK
   KA7EHK
KA7EHK de N7AVK    5-Mar 0718Z >
sh/users
Users connected to local PacketCluster node (N7AVK)
    KC7EM  WA6SDR  AI7B     W7ZR    WK7Z   K7UN
    KA7EHK
KA7EHK de N7AVK    5-Mar 0719Z >
```

7.B.4 CONFIGURATION: The configuration list shows which nodes are currently networked with the one to which you are connected. This list tells you nothing about the physical layout of linked nodes. But it does show which nodes are currently in the system and which stations are current users of each node. The list of current users follows the conventions of the user list described in section 7.B.3. There is also a *show/configuration/nodes* which the author does not find vary useful. The basic configuration list looks like this:

```
KA7EHK de N7AVK    3-Apr 2237Z >
sh/config
PacketCluster Configuration:
   Node                       Connected stations
(N7AVK)            W7AEP      KC7EM      WA6SDR      W7ZR       K7UN
                  (AI7W)       N6TR     (KC7EI)      AI7B       N7NHR
                   WK7Z        N7MCA     WA7GCS      KA7EHK
(WR7D)             W7QK       (AB9O)     W7EYE       WB7SRW     K7LJ
                  KG7FV       WA2TMP     W7BG        AA7AX      W7UZ
                   W7GUR
(N0JO)           (KA0EPR)     KB7DA       W7ZI       K7KJM        W7XN
                   K7RO        K9JF      (N7PKB)     K7IFG      KB7WW
                  (N7JB)       AA7EA      K7OZ        AD7L       NK7L
                   W7LI        N7CWR      W7IMP       KI7JA      KI7FG
                  KE7CX        W7KJZ
(NV6Z)           (KY7X)        W9ELB     (KA7MCX)     KA7CSE     WA0RJY
                   N6MZ        W7LZP      KF7GH       KQ4O       WA7GMY
                  WA7ECU       K7LXC       W7ND       K7PVV     (K7RIE)
                  KI7EK        KA7ZWO      W7WA       K7WTG      W7WT
                  NV6Z-9       N7IVM
(WY7I)            WB7RAL      KB7GUH      KD7IK       KF7QZ
(N7FSW)            K7LZJ       K7UU        N7EF       N7LTF      AA7FT
                  (W7OM)       N0AX        K7DS       W7JEN       K7QQ
                   K7RXV      AA7TC       NX7K        N7YQW
(VE7CQD)         (VE7CC)      VE7IO      (VE7FQN)     WB7PMV     KB7UG
                 (VE7SOL)     KA7AUH      VE7CON      VE7ADC      N7RO
                  VE7ON        N7MC        VE7AVM      WB7PMU     KB7TW
                  VE7HDE       W7KCZ       VE7CQ      (VE7IU)    (WA7ZWG)
                  KB7IGR      KB7MSU       W7EKM       KI7X       WB7CLU
                  WB7WQE       VE7EW       VE7SZ       VE7NIN      W7KCN
                  WB7CAO      (VE7VR)       W7SFF      VE7ASR     VE7SV
                  AA7KE       (VE7HNC)     VE7AGC
VE7GCE
VE7AV-5
VE7PL
KA7EHK de N7AVK    3-Apr 2237Z >
```

7.C DX SPOTTING SERVER

DX spotting consists of two components. One is the immediate announcement and the other is data base information.

7.C.1 IMMEDIATE ANNOUNCEMENT: The immediate announcement is sent by any user who wishes to make an announcement. The announcement is made with the command:
DX frequency callsign information.

For example, if you wish to tell everyone that 9G1AA was just heard on 14020.0 (KHz) and that he said that he would be operating every day at 0100Z, you might type *DX 14020.0 9G1AA every day at 0100Z.*.

Everyone else who is connected (as long as they did not *SET/NODX* or have their callsign filter set to ignore

this call) would see the message. A typical set of announcements is like the following:

```
KA7EHK de N7AVK     1-Apr-1993 0357Z    Type H or ? for help >
DX de KS7P:       7005.0  9G1AA        Wid lotsa lids on him!   0405Z
DX de VE7CC:      3795.0  W5IJU/KP1    up 3                     0412Z
```

7.C.2 NODX: If you do not want to see the DX announcements, you would type *SET/NODX*. If you have turned off the DX announcements and wish to turn them back on, you may type *SET/DX*.

7.C.3 DX FILTERING: Filtering is a method of eliminating those announcements which are of no interest to you. It also reduces activity on the node frequency if you are going to ignore it anyway. The basic format is *SET/FILTER mode/BAND=(x,x,x) DXCC-prefix(es)*.

Valid numbers for bands are 160, 80, 40, 30, 20, 17, 15, 12, 10, 6, and 2. These are (obviously) the meter designation for all of our operating bands from 160 meters to 2 meters. The word "ALL" may be used for both band and prefix. Valid entries for mode include CW and SSB; other modes such AM or FM are not recognized. Digital is recognized on the basis of frequency; PACKET,RTTTY, AMTOR are not distinguished. If a mode designation is left out, it is assumed to be CW/SSB. For example, if you want to filter out all activity on 2 meters, 6 meters, and 10 meters, you could type

SET/FILTER BAND=(2,10,6) ALL or

SET/FILTER CW/SSB/BAND=(6,2,10) ALL

Similarly, to filter out all JA, VE, VK on CW on 80 meters and 40 meters, type

SET/FILTER CW/BAND=(40,80) JA,VE,VK

If you wish to clear a previously set filter, the command *SET/NOFILTER* may be used.

7.C.4 CALLSIGN PREFIXES: One of the frequent puzzles for filter and other DX related commands is the recognized prefix which is appropriate for the command. You can find out using the command *show/prefix prefix* where prefix is your best guess. For example, most of us know that KL7 is Alaska (hardly DX). But under DXCC rules, it counts as a country. Here is what the show/prefix says about KL7:

```
show/prefix KL7
    KL7   Alaska-Anchorage-KL7  CQ 01  ITU 01
    KL7   Alaska-Fairbanks-KL7  CQ 01  ITU 01
    KL7   Alaska-Juneau-KL7     CQ 01  ITU 01
    KL7   Alaska-Nome-KL7       CQ 01  ITU 01
KA7EHK de N7AVK    3-Apr 2110Z >
```

The preceding list shows how major cities in a country are designated with respect to prefixes. In an unfamiliar country, it helps to determine which is the prefix to use FOR DX SPOTTING LIST purposes.

Similarly, for the prefix VP gives:

```
   VP2E   Anguilla-VP2E         CQ 08  ITU 11
   VP2M   Montserrat-VP2M       CQ 08  ITU 11
   VP2V   Tortola-BVI-VP2V      CQ 08  ITU 11
    VP5   Turks-Caicos-VP5      CQ 08  ITU 11
    VP8   So-Georgia-VP8/G      CQ 13  ITU 73
    VP8   So-Orkney-VP8/O       CQ 13  ITU 73
    VP8   So-Sandwich-VP8/SA    CQ 13  ITU 73
    VP8   So-Shetland-VP8/SH    CQ 13  ITU 73
    VP8   Falkland-Is-VP8/F     CQ 13  ITU 16
  VP8/F   Falkland-Is-VP8/F     CQ 13  ITU 16
  VP8/G   So-Georgia-VP8/G      CQ 13  ITU 73
  VP8/O   So-Orkney-VP8/O       CQ 13  ITU 73
 VP8/SA   So-Sandwich-VP8/SA    CQ 13  ITU 73
 VP8/SH   So-Shetland-VP8/SH    CQ 13  ITU 73
KA7EHK de N7AVK    3-Apr 2106Z >
```

The latter list shows that VP8 applies to all of South Georgia, South Orkney, South Shetland, and the Falkland Islands. If you wish to specify a specific one of these, you would use, for example, VP8/F for Falkland Islands.

The 3rd & 4th columns go together, indicating the CQ Magazine Worked All Zone zone number. The 5th and 6th columns likewise go together, indicating the ITU zone number.

7.C.5 NEEDED COUNTRIES: When only a few countries are needed, it is much simpler to specify those few than all which are not needed. This is done with the *SET/NEED mode/BAND=(x,x,x) DXCC-prefix(es)*. Note that the format is essentially the same as FILTER.

To clear a previously set need list, send *SET/NONEED*.

7.C.6 DATA BASE: The DX data base is stored locally on each node. This is possible since all of the immediate DX announcements are sent to all nodes in a linked system.

There are several commands to access this data base. The basic form is *SH/DX*. This command returns the most recent 10 reports.

```
SH/DX
  7011.0  ON4ACG      30-Mar-1993 0603Z                    <NX7K>
  7005.0  KP1/NF6S    30-Mar-1993 0557Z  QSX UP            <NX7K>
  7001.3  J52AG       30-Mar-1993 0555Z                    <NX7K>
 14255.8  UI8QU       30-Mar-1993 0455Z  OBL#185 QSL K9FD  <W7EYE>
 14179.0  UI8ZAC      30-Mar-1993 0446Z                    <W7EYE>
 14020.0  9G1AA       30-Mar-1993 0350Z  UP 2/10           <N7TT>
 14194.5  W5IJU/KP1   30-Mar-1993 0326Z                    <N7TT>
 14020.0  9G1AA       30-Mar-1993 0300Z   wkd @ 034.2      <K7LAY>
 14020.0  9G1AA       30-Mar-1993 0244Z  Nw QSX 032.5      <W7HR>
 21020.0  9G1AA       30-Mar-1993 0220Z  up                <WA7BPI>
KA7EHK de N7AVK   30-Mar 0726Z >
```

This list is pretty straight forward. First column is the frequency, The second is the call of the DX station. Next come the date and time reported. This is followed by and information column and the last is the call of the reporting station.

It is possible to show quite a variety of combinations and selections from the DX data base. The next list is one which shows the reports over a specific frequency range; in this case, it is 21000 to 21999 KHz.

```
SH/DX 21000-21999
 21020.0  9G1AA       30-Mar-1993 0220Z  up                 <WA7BPI>
 21267.0  ZD7SM       29-Mar-1993 2029Z  ...sri...          <N7IXG>
 21267.0  ZD1SM       29-Mar-1993 2029Z  Maggie St. Helenia <N7IXG>
 21020.1  9G1AA       29-Mar-1993 2019Z  up 2/10            <N7EF>
 21267.0  ZD7FM       29-Mar-1993 1955Z  maggie st helenia  <KC7HS>
 21245.0  W5IJU/KP1   29-Mar-1993 1911Z  JA8RUZ OP          <NN7L>
 21005.0  C91J        29-Mar-1993 1842Z  JOHN               <W7KJJ>
 21293.2  9G1AA       29-Mar-1993 1631Z                     <WA6SDR>
 21021.3  HT1T        29-Mar-1993 1538Z  VIA SM0KCR         <W7AM>
 21021.3  ST1T        29-Mar-1993 1533Z  VIA SM0KCR         <W7AM>
KA7EHK de N7AVK   30-Mar 0728Z >
```

One may also search chronologically, by band, by prefix, by callsign fragment and by comment text. ***SHOW/DX/n*** lists the most recent "n" reports. By frequency range uses ***SHOW/DX/f1-f2*** where f1 and f2 are the upper and lower frequency limits in kilohertz (in either order); the previous example used this form. The prefix form is used to show where (frequency) a given prefix has been most recently heard; the

command is *SHOWDX prefix* where the prefix used is one of the prefixes from the SHOW/PREFIX list. For example, if one wants to find out where and when stations from the Pitcairn Island have been operating, one would send:

```
show/dx vr6
 10101.6  VR6BB        2-Apr-1993 0424Z                <N6MZ>
 14020.0  VR6BB        2-Apr-1993 0140Z                <K7LJ>
 14020.0  VR6BB       31-Mar-1993 0325Z                <W7KCN>
 10101.0  VR6BB       29-Mar-1993 0453Z                <N7JB>
 14020.0  VR6BB       29-Mar-1993 0137Z  up 3          <K7DBV>
 14020.0  VR6BB       29-Mar-1993 0137Z  qsx up 3      <K7DBV>
 28491.0  VR6JJ       28-Mar-1993 1953Z                <WX7R>
 28488.5  VR6JJ       28-Mar-1993 1814Z                <N7JB>
 14261.0  VR6BX       28-Mar-1993 0420Z  brian         <WA7GMY>
 28505.0  VR6JJ       26-Mar-1993 2320Z                <N7AVK>
KA7EHK de N7AVK    3-Apr 2206Z >
```

The usefulness of this list should be self-evident if you are looking for a specific country!

7.D CONFERENCE SERVER

The DX Spotting Network conference server is not greatly different from other conference servers except that it is a distributed server. This means that a conference may be spread over several nodes in a linked system.

Be aware that this server has several limitations. If several stations on the same node are in a conference, a packet must be sent to each participant. This may make the local user frequency quite busy. If users are on several different nodes, the throughput will drop if conference packets have to compete on the linking frequency with other packets.

There are two conference modes. The first is the one-on-one or talk mode. The second is the conference mode.

7.D.1 TALK MODE: The talk mode is directed to a single user on any of the nodes which are linked. You can find out who the current users are with the *sh/users/all* or *sh/users* commands (see section 7.B.3). The command is simply *T callsign.*

```
KA7EHK de N7AVK   30-Mar 0723Z >
tk7un
```

```
All further input will be sent to K7UN
Exit talk mode by typing a ctrl/Z or /EXIT on a new line
Don - are you there de KA7EHK
will leave msg for you on SRABBS.  Bye
/EXIT
Talk terminated
KA7EHK de N7AVK   30-Mar 0725Z >
```

This attempt was not particularly successful but it still demonstrates how TALK works. K7UN was on the user list, so the author sent *t k7un*. The node then responds with the message that all which is typed will be sent to K7UN. Another line indicates how to exit from TALK mode. Two lines were typed with no response from K7UN. Then talk is ended with an *EXIT* command. The node then shows that your talk is, indeed finished.

7.D.2 CONFERENCE MODE: There are two levels of conferencing mode. One is local (that is, limited to your local node) and the other is full (that is, extending to all other conference users on all linked nodes.

```
confer
*** Entering local conference mode ***
Exit conference mode by typing a ctrl/Z or /EXIT on a new line
/exit
KA7EHK left the conference
KA7EHK de N7AVK    3-Apr 2239Z >
confer/full
*** Entering cluster-wide conference mode ***
Exit conference mode by typing a ctrl/Z or /EXIT on a new line
anybody here?
/exit
KA7EHK left the conference
KA7EHK de N7AVK    3-Apr 2240Z >
```

The first try was with the local conference server. Nobody else was using the conference (as observed with the user list, not shown this time). This simply shows how to enter and exit a conference. The second half enters the cluster-wide conference. Again, there were no other users and no response to the query.

7.E MAIL SERVER

The mail server works somewhat similarly to that of the "store-and-forward" BBSs described in Chapter 6. Be aware, however, that there are generally no cross-connections between the DX Spotting Network and the store-and-forward BBS system. Thus, a message

addressed to someone who does not use the specific (linked) spotting system which you use WILL NOT BE DELIVERED!

7.E.1 READING MESSAGES: If you have a waiting message, you will be notified when you log on to the spotting node. An example is this one:

```
cmd: c n7avk
*** CONNECTED to N7AVK
Hi Jim!  You've been Digitalized to Mother-Cluster Node N7AVK
Cluster:  7 nodes, 16 local / 106 total users  Max users 154  Uptime
6 17:49
You have the following new mail:
 Msg   Size        To      From    Date  Time       Subject
286    200    KA7EHK     N7AVK   1-Apr 0508Z  Re: MODE IN SET/FILTER

KA7EHK de N7AVK     3-Apr-1993 2058Z    Type H or ? for help >
```

Similarly, if a message arrives while you are connected, a similar notification is sent to you.

Messages may be read several ways. A simple *read* reads all messages addressed to you, starting with the oldest first. A *read ###* reads the message with the number specified.

7.E.2 SENDING MESSAGES: The basic method of sending a message is the standard *SEND callsign*. When you do this, the node responds with a message number and a request for a message subject. Once the subject is entered, there is a prompt for the body of the message and information about how to end it.

```
KA7EHK de N7AVK    3-Apr 2100Z >
s n7avk
Message #325    Enter subject (29 characters)
help?
Enter text.  Finish with ctrl/Z or /EXIT or cancel with ctrl/Y.
```

Users should be aware that there are two classes of messages, private and non-private! It is possible for the Pavillion DX nodes to be set up so that messages are always private (unless specified otherwise) or are always non-private (unless specified otherwise). You may always specify a message to be private by using *SEND/PRIVATE callsign*. Any non-private message can be read by anyone. See section 7.E.5 for an example of a message & bulletin list containing both private and non-private messages.

It is also possible to send a copy of a message to somebody else. The original may be one you originated or it may be one which was addressed to you. In either case, the command is *SEND/COPY ####.callsign*.

A third method of sending a message is as a reply to a message sent to you. The reply is directed back to the station which sent the message to you. It applies to the message YOU JUST READ. The command is simply *reply.*

7.E.3 LISTING YOUR MESSAGES: Messages which are addressed to you or where sent by you may be listed with the *directory/own* command. Here is what happens:

```
KA7EHK de N7AVK    3-Apr 2330Z >
directory/own
 Msg   Size        To      From    Date  Time       Subject
326    620     N7AVK    KA7EHK   3-Apr 2136Z show/prefix
  325    447     N7AVK    KA7EHK   3-Apr 2104Z Lew -
  286-p  200    KA7EHK     N7AVK   1-Apr 0508Z Re: MODE IN SET/FILTER
KA7EHK de N7AVK    3-Apr 2331Z >
```

7.E.4 DELETING MESSAGES: Once read, messages do not automatically disappear. You have to command each message to be deleted.

```
delete 286
Message 286 deleted
KA7EHK de N7AVK    3-Apr 2332Z >
```

7.E.5 LISTING BULLETINS: Bulletins and non-private messages may be listed with the *directory* command. There are several common options. Section 7.E.3 showed how to use this command to list your own messages. The */new* option lists all the (non-private or your own) messages and bulletins since you last used the directory command. The */all* lists all active (non-private or your own) messages and bulletins. The */bulletins* lists bulletins, only.

```
directory/new
 Msg   Size        To      From    Date  Time       Subject
326    620     N7AVK    KA7EHK   3-Apr 2136Z show/prefix
  325    447     N7AVK    KA7EHK   3-Apr 2104Z Lew -
  324    240      KA6V    KB7IVU   3-Apr 1952Z 3c
  320    382     W6HCS    KB7IRQ   3-Apr 0338Z OK, sounds good.  Hope
286-p  200    KA7EHK     N7AVK   1-Apr 0508Z Re: MODE IN SET/FILTER
  269    381     N7SBI     KC7HS  31-Mar 1459Z hello roy
```

```
  264    223      WANT    WB7TGZ  31-Mar 0328Z ROHN "45" SECTIONS
  247     92      WANT     AA7UP  30-Mar 0822Z rohn 25-g sections
  162    110    WANTED     W7CQR  25-Mar 1537Z AEA Doctor-QSO
  142    117   FORSALE      KO7N  24-Mar 1600Z HD CREATE RC5a-3 ROTOR
  141     66   FORSALE      KO7N  24-Mar 1555Z KLM 40M-4
  140     71   FORSALE      KO7N  24-Mar 1554Z KLM 20M-6
  129    135     LOCAL      W7AM  23-Mar 0144Z DX LUNCH
   25    898     LOCAL      AB9O  14-Mar 2240Z thanks for sh/qsl
   19    621   FORSALE      W7ZR  11-Mar 2306Z COMPUTER STUFF
   18    131      WANT      WJ7S  11-Mar 0729Z XTALS FOR IC 22A
   16    348    KA7CYA      WX7R  11-Mar 0135Z hello tom!
KA7EHK de N7AVK    3-Apr 2327Z >
```

7.E.6 READING BULLETINS: Bulletins are read just like personal messages with a *read ####* command.

7.E.7 SENDING BULLETINS: Bulletins are sent just like messages. The only difference is how it is addressed. The directory list, above, gives an idea of how bulletins might be addressed.

7.F TIME SERVER

The time server shows the current local time and the time at DXCC prefix locations.

```
KA7EHK de N7AVK    4-Apr 0006Z >
show/time
 4-Apr-1993  0007Z
KA7EHK de N7AVK    4-Apr 0007Z >
show/time vr6
    VR6   Pitcairn-Is-VR6        Local (standard) time 16:17
KA7EHK de N7AVK    4-Apr 0007Z >
```

The basic *show/time* gives the local UTC. The *show/time prefix* shows the local time at the indicated prefix. Again, the recognized prefixes are those listed in the *show/prefix* command (see section 7.C.4).

Also related to the time server is sunrise and sunset information. The basic command is *show/sun*. Without any prefix, this command returns the local sunrise and sunset IF YOU HAVE GIVEN YOUR LATTITUDE/LONGITUDE with a *set.location* command. The *show/sun prefix* option gives the sunrise and sunset at the prefix specified in terms of UTC.

```
show/sun
*** No prefix specified and no location information for you was found
***
KA7EHK de N7AVK    4-Apr 0008Z >
show/sun vr6
VR6   Pitcairn-Is-VR6   Sunrise: 1450Z   Sunset: 0236Z
```

7.G HEADING SERVER

The standard command to obtain the heading to a prefix location is *SHOW/HEADING prefix.* The short great-circle route is given as the primary heading and the long great-circle route is given as the reciprocal heading.

```
KA7EHK de N7AVK    4-Apr 0008Z >
show/heading vr6
VR6 Pitcairn-Is-VR6: 187 degs - dist: 4848 mi, 7801 km  Reciprocal
heading: 5 degs
KA7EHK de N7AVK    4-Apr 0009Z >
```

7.H WWV SERVER

7.H.1 WWV DATA BASE: The WWV server displays WWV propagation information which has been entered by users. This information includes the date and time of the announcement, the three index numbers which WWV broadcasts, and the descriptive forecast. The meaning of the indices and descriptive forecast are given in magazine articles about propagation forecasting and in the ARRL Handbook. A typical example is:

```
show/wwv
   Date      Hour  SFI   A   K         Forecast
 4-Apr-1993  00   117   1   1  low, quiet !!!!!          <VE7CQD>
 3-Apr-1993  21   117   2   0  SA LOW,GMF QUIET          <W7GUR>
 3-Apr-1993  18   121   5   0  low/quiet                 <N6MZ>
 3-Apr-1993  15   121   5   2  Low / Quiet               <N7VZF>
 3-Apr-1993  00   121   5   2  low, quiet                <KA7MCX>
 2-Apr-1993  21   121   4   1  SA LOW,GMF QUIET          <W7GUR>
 2-Apr-1993  18   124   8   0  low, quiet                <KA7MCX>
 2-Apr-1993  15   124   8   1  low/quiet-unset           <N6MZ>
 2-Apr-1993  12   124   8   2  low/quiet-unset           <N6MZ>
 2-Apr-1993  03   124   8   2  low, quiet to unsettled   <KA7MCX>
KA7EHK de N7AVK    4-Apr 0125Z >
```

7.H.2 WWV ANNOUNCEMENTS: Each time a WWV announcement is made, it also appears along with the DX announcements unless you have disabled these announcements with the command *set/nowwv_announcements*. The WWV announcement turnoff may be turned back on with *set/wwv_announcements.* An example of a WWV announcement is:

```
KA7EHK de N7AVK    4-Apr 0009Z >
DX de WK7Z:      14030.0  A71CW        WORKING SEVENS           0022Z
DX de W7OF:      14196.5  4N5ET        LOUD                     0019Z
DX de N7IXG:     21295.0  9G1AA        werking simplex by ###'s 0052Z
WWV de VE7CQD <00> :   SFI=117, A=  1, K= 1, low, quiet !!!!!
```

7.H.3 MAKING A WWV ANNOUNCMENT: WWV announcements may be made by anyone who hears WWV broadcasts. The format is *wwv SF=xxx, A=yy, K=zz, forecast*. You simply type out this message and replace the xxx, etc with the numbers from the broadcast.

7.H.4 MUF INFORMATION: A byproduct of the WWV information is the ability to compute MUF (Maximum Usable Frequency) for the path to a specified location (ie, prefix). The command is of the form *show/MUF prefix.* Another example for Pitcairn Island is:

```
KA7EHK de N7AVK    4-Apr 0125Z >
show/muf vr6
Pitcairn-Is-VR6 Propagation:  Flux: 117  Sunspots: 67  Rad Angle: 7
   Dist: 7800 km   Hops: 3   MUF (90%):18.4  (50%):21.7  (10%):26.5
KA7EHK de N7AVK    4-Apr 0301Z >
```

The MUF figure given is in MHz for the path to the specified destination. The preceding example says that the MUF will be at least 18.4MHz 90% of the time, it will be as high as 21.7MHz 50% of the time, and it will be as high as 26.5MHz 10% of the time.

7.I DATA BASE SERVER

The Pavillion DX Spotting Node software has the ability to function as a distributed data base and as a server to that data base. Earlier sections of this chapter have already considered some functions which really are aspects of data base service. These include show/prefix, show/wwv, and show/dx. A few will be described in later sections of this chapter.

7.I.1 DATA BASE LIST: The data bases which are available are listed with the simple *show* command:

```
show/commands
SHOW/OBLAST
SHOW/WVDXC
SHOW/CLUB
SHOW/BUREAU
SHOW/FLUX
SHOW/ZONE
SHOW/CONTEST
SHOW/QSL
SHOW/QSLNEW
SHOW/IRC
SHOW/RULES
SHOW/ALLOC
SHOW/HELP
SHOW/DXNODES
SHOW/DEALER
SHOW/DXCC
SHOW/BAND
SHOW/FCC
SHOW/OPINFO
SHOW/COORD
SHOW/IOTA
SHOW/TODAY
SHOW/PUB
SHOW/COUNTY
SHOW/LADDER
SHOW/QSLREC
SHOW/BUCKMASTER
SHOW/MIC
SHOW/SCORES
KA7EHK de N7AVK    4-Apr 0519Z >
```

This list really contains recognized *show* commands for data base access. If you enter any of the above commands, the response will first tell you if it is accessing a remote data base. Then there is a short answer if the data base is present . This answer tells you how to obtain the information which is stored within the data base. Many of the data bases listed above appear to be third-party data bases; that is, they were assembled by a person somewhere else and distributed to DX Spotting Node SYSOPS. It is quite likely that not all of these are available on all systems or that the list above contains all of the possible data bases. It is also likely that this list will change over time.

7.I.2 DATA BASE SUMMARIES: For those data bases listed above which are actually present, here are the access summaries. Note that in the portion of the DX Spotting System which is near the author (northwest Oregon), the data bases are distributed on at least four other

nodes. It is likely that other sections of the network have their own data bases to reduce data base message activity on portions of the network which join major metropolitan areas. Data bases which are absent are not included

```
KA7EHK de N7AVK    4-Apr 0519Z >
show/oblast
The SHOW/OBLAST command is used to provide the oblast number, CQ zone
and ITU zone for a specified Russian prefix.

  For UA1,2,3,4,6,8,9,0, use the number in the call, e.g.,
SHOW/OBLAST UA3N
  For others, use a hyphen instead of the number,  e.g.,
SHOW/OBLAST UH-W

You may also enter a number to get the oblast name and prefix:
  SHOW/OBLAST 111.

(Please report any corrections to and provided by K1KI)
7/2/89
```

Note that oblasts are Russian political subdivisions (like counties?)

```
KA7EHK de N7AVK    4-Apr 0528Z >
show/wvdxc
Accessing remote database on N0JO...standby...
KA7EHK de N7AVK    4-Apr 0529Z >

   The SHOW/WVDXC command is used to provide info on the WVDXC
members.

To access info on the WVDXC members type SHOW/WVDXC Call .
Replace 'Call' with the call of the club member you are requesting
info on.

   To update your file in SH/WVDXC use the UPDATE/WVDXC  command.
   ? UPDATE   -  For additional info on update command.
   ? UPDATE/APPEND - For info on how to add more to ur file.

You will only be allowed to update your own file.  Anyone is welcome.
```

Note that WVDXC is the Willamette Valley DX Club. Thus, this file, if present, will have the name or abbreviation of a local DX club.

```
KA7EHK de N7AVK    4-Apr 0533Z >
show/qsl
Accessing remote database on WR7D...standby...
KA7EHK de N7AVK    4-Apr 0533Z >
QSL lookup data from the  W6GO/K6HHD QSL Manager List may be obtained
by typing  <SHOW/QSL call>,  where  call is the  callsign of the DX
station you  wish to look  up.   This  database is provided  as a
service to the W6GO/K6HHD QSL Manager List subscribers who use  this
Packet Cluster. If a local QSL database is  present and the  callsign
you have requested is present in the  local database,  the local
database  information will be sent to you before the information from
the W6GO/K6HHD QSL Manager list.
```

~

KA7EHK de N7AVK 4-Apr 0534Z >
show/qslnew
Accessing remote database on WR7D...standby...
KA7EHK de N7AVK 4-Apr 0534Z >
Please place new QSL information into QSLNEW. QSLNEW is a database which you create. It is searched in addition to the W6GO/K6HHD QSL Manager list whenever you ask for a QSL route. To add or correct a QSL route, please TYPE UPDATE/QSL and enter the data as prompted. When you have completed your entry, on a new line type /EXIT<ENTER> or <CTRL-Z><ENTER>.
~
If you wish to add information to what is already in QSLNEW, you may append additional data to an existing entry by typing UPDATE/QSLNEW/APPEND rather than typing UPDATE/QSLNEW.
~
Your SYSOP will forward this information monthly for use in updating the QSL database. 73 de W6GO and K6HHD. 14-Dec-90 W6GO

KA7EHK de N7AVK 4-Apr 0536Z >
show/rules
Accessing remote database on N0JO...standby...
KA7EHK de N7AVK 4-Apr 0538Z >
The SHow/RULES command is used to display sections of FCC Rules and Regulations, Part 97, covering the Amateur Radio Service, and sources for information on FCC Rules and Regulations publications. [12/31/91]
~
   SH/RULES [sect #] to read a Section number Ex: SH/RULES 97.115
   SH/RULES INDEX to list Subparts/Sections
   SH/RULES PUB to list Rule publications
   SH/RULES AUTHOR to provide comments, corrections, updates

KA7EHK de N7AVK 4-Apr 0539Z >
show/alloc
Accessing remote database on N0JO...standby...
KA7EHK de N7AVK 4-Apr 0539Z >
The SHOW/ALLOCATION command is used to obtain the country which is allocated the specified ITU prefix block. The qualifier should be a two character prefix. Valid characters are A-Z and 0-9 (two numbers are not valid). If a single valid character is entered, all allocated blocks for the character will be displayed.
~
   Syntax: SHow/ALlocation xx or x
~
This database was provided by K3ARV of the Melbourne, FL PacketCluster node.
Please send updates and corrections to K3ARV. Distributed by W6GO/K6HHD

KA7EHK de N7AVK 4-Apr 0541Z >
sh/help

```
Accessing remote database on N0JO...standby...
KA7EHK de N7AVK    4-Apr 0541Z >
The SHOW/HELP [file] will provide some system and operating tips
on using the DX PacketCluster network.  Most of these files have
been messages previously uploaded by K6PBT and now contained in a
database.  If you have any comments or suggestions that you think
would be of help to other users in using this network, please send
them to K6PBT to be added to this HELP database.
~
SH/HELP [file]; files are: CONNECTED, CANCEL, TIPS, COMMANDS,
NETWORK,
TNC and NEWUSER.


KA7EHK de N7AVK    4-Apr 0542Z >
sh/dxnodes
Accessing remote database on N0JO...standby...
KA7EHK de N7AVK    4-Apr 0543Z >
This database lists DX Nodes by STATE: SH/DXNODES VA
and by AFFILIATION:                    SH/DXNODES PVDXSN
-
For a list of Affiliations type SH/DXNODES AFF
-
Please send changes/updates to your SYSOP for forwarding to NV6Z
-
This Database is Distributed by W6GO/K6HHD.
```

The preceding data base is the source for Appendix 11.

```
KA7EHK de N7AVK    4-Apr 0546Z >
show/band
Accessing remote database on N0JO...standby...
KA7EHK de N7AVK    4-Apr 0548Z >
TO FIND THE OPERATING PRIVILEGE FOR A CLASS OF LICENSE DO THE
FOLLOWING:
~
1. TYPE SH/BAND DIR THEN ENTER.
2. LOCATE THE BAND AND LICENSE CLASS FOR INFORMATION YOU NEED
3. FIND KEYCODE FOR BAND AND LICENSE CLASS IN ITEM 2
4. TYPE SH/BAND KEYCODE (USE THE KEYCODE LISTED) THEN ENTER
~
HOPE YOU DON'T GET A PINK SLIP NOW!
~
Updates/corrections to KE5IV.      5/90 - Distributed by W6GO/K6HHD


KA7EHK de N7AVK    4-Apr 0550Z >
show/coord
Accessing remote database on N0JO...standby...
KA7EHK de N7AVK    4-Apr 0550Z >
The SHOW/COORDinates command provides the longitude and latitude of
various cities in the United States and DX locations.  You may use
this information to set your location (SET/LOCATION).  Enter SH/COORD
[key] where key is a 2-letter state designator, example SH/COORD CA;
or SH/COORD [pfx], example SH/COORD VK.  A plus (+) indicates
airport/VOR location.
```

~
Your updates and comments are welcomed. Type SH/COORD AUTHOR for info.
Database by: K6PBT Distributed by W6GO/K6HHD via DX-BBS and GODISK.

KA7EHK de N7AVK   4-Apr 0551Z >
sh/iota
Accessing remote database on N0JO...standby...
KA7EHK de N7AVK   4-Apr 0551Z >
SHow/IOTA (Islands on the Air) displays requested IOTA island data and name cross-reference information. For official IOTA status/info, one should consult a current IOTA Directory. SH/IOTA DIR or NOTES for more.
~
* IOTA Ref Nbr   SH/IOTA OC-7, NA-113, etc.   (Continent plus -Ref#)
* Island Names   SH/IOTA EUA, ASB, SAC, etc. (Continent plus A - Z)
~
Your updates and comments are welcomed. Type SHow/IOTA AUTHOR for info.
Prepared by: K6PBT   Distributed by W6GO/K6HHD via DX-BBS and GODISK.

KA7EHK de N7AVK   4-Apr 0553Z >
show/pub
Accessing remote database on N0JO...standby...
KA7EHK de N7AVK   4-Apr 0553Z >
~
The SHow/PUB command is used to display information on Amateur Radio publications from various countries. A simple process is provided for adding publications to this database.
~
SYNTAX: SHow/PUB KEY How to search for pubs from a specific country
        SHow/PUB ADD How to add a publication to this database
~
Your updates and comments are welcomed. Type SH/PUB AUTHOR for information.
Database by N6IXX   Distributed by W6GO/K6HHD   13-August-90
~

KA7EHK de N7AVK   4-Apr 0600Z >
sh/qslrec
Accessing remote database on N0JO...standby...
KA7EHK de N7AVK   4-Apr 0600Z >
The SH/QSLREC command is used to display information on QSL cards received by users of this Cluster. You can easily update QSLREC with information on QSL cards you receive by using the UPDATE (OR) APPEND command (see below).
~
SHow/QSLREC (Call)   Check for QSLs received from a specific station
UPDate/QSLREC   Add NEW received QSL info to the QSLREC database
UPDate/QSLREC/APPend Add MORE received QSL info to an EXISTING QSLREC entry
~
Your updates / comments are welcomed. Type SH/QSLREC AUTHOR for information.
Database by N6IXX   Distributed by W6GO/K6HHD   1-September-90

```
KA7EHK de N7AVK    4-Apr 0601Z >
show/buckmaster
Accessing remote database on WR7D...standby...
KA7EHK de N7AVK    4-Apr 0601Z >
FCC records plus VE and some DX provided by ab9o, updated Oct. 92
```

This data base is discussed in some more detail in the next section.

```
KA7EHK de N7AVK    4-Apr 0519Z >
show/mic
Accessing remote database on N0JO...standby...
KA7EHK de N7AVK    4-Apr 0523Z >
                          MicPlug Database
                   For Different TNC and for other uses
                          Rev: Oct 11, 1990
~
    This  database  is  to  search different types of Radios to see
how and where to connect your mic plug wires  to.   The  database
contains  direct instructions on MFJ, DRSI, PK232, PK88 and other
TNC's, but you can use the data  for  all TNC's as well.  To see
available radios in the database do a [SHOW/MIC  INDEX].  For
information  concerning  the  programmer  [SHOW/MIC AUTHOR]
```

The preceding data base is used as part of the information for Appendix 4.

```
KA7EHK de N7AVK    4-Apr 0525Z >
show/today
Accessing remote database on N0JO...standby...
KA7EHK de N7AVK    4-Apr 0525Z >
SHow/TODAY was inspired by a PC program called TODAY by Patrick
Kincaid. Enlighten your QSO's with a topic from a daily view of
TODAYs databank of history events.  For updates or comments, SH/TODAY
AUTHOR.
~
   SH/TODAY [date] - where [date] is a 4-digit number, 01-12 for
      the month, and 01-31 for the day; ie. SH/TODAY 0521  would
      display events for May 21st.
~
Included is a perpetual calendar covering the years 1970 to 2029.  To
find a day/date for a particular year/month, SH/TODAY CALENDAR.  Try
it!
KA7EHK de N7AVK    4-Apr 0526Z >
```

7.J CALLBOOK SERVER

Of the data base servers described in the previous section, the callbook server will be examined in a little more detail. This is primarily for comparison with the other callbook servers described in section 5.D.

Note that this particular data base includes Canadian and some DX. The following example shows the response to a request for the author's call and for for VE7DIE.

```
KA7EHK de N7AVK   30-Mar 0735Z >
show/buckmaster KA7EHK
Accessing remote database on WR7D...standby...
KA7EHK de N7AVK   30-Mar 0736Z >
HamCall (c) 1992, Buckmaster.  Licensed for non-pecuniary use only.
James D. Wagner, KA7EHK    License class: T    Born: '41
31677 N Lake Creek Dr
Tangent, OR 97389
KA7EHK de N7AVK   30-Mar 0737Z >
show/buckmaster ve7die
Accessing remote database on WR7D...standby...
KA7EHK de N7AVK   30-Mar 0737Z >
HamCall (c) 1992, Buckmaster.  Licensed for non-pecuniary use only.
Lawrence Micheal Joe, VE7DIE
4174 Cross Haven Close
Victoria Bc,    V8X 4H3     Canada
KA7EHK de N7AVK   30-Mar 0738Z >
```

7.K OTHER DX SPOTTING NODES

Recent versions of the MSYS BBS software includes a DX Server. Since MSYS is full-service store-and-forward BBS software, the mail service follows that of a normal BBS rather than the slightly different style described in this chapter. It is not likely that MSYS DX spotting would network easily with the Pavillion node software previously described.

In its simplest form, any of the converse servers can be used for DX spotting. While such DX spotting would be without all of the bells and whistles relating to callsign filtering and the like, there is no reason why it could not work. The distributed converse server found in JNOS and other NOS versions could also implement a distributed DX spotting system. While the author has no first-hand knowledge of such systems, there is no (obvious) practical reason why they should not work in this application.

7.L SUMMARY

This chapter has discussed one specific implementation of a DX Spotting Node. There are several commands such as *upload* and

download which have not been discussed. This is because both space is limited and it was not felt that these would be commonly used commands.

If you encounter other styles of DX spotting nodes, just be aware that they are likely to be fairly similar to what has already been described.

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PRINCIPLES OF RADIO NETWORKING

The primary focus of this chapter is the basic concept of radio networking. The ideas are not difficult. Unfortunately, however, the language which is often used can be difficult to understand because of the intense academic study around networking. Those terms which really do apply to ham networks will be explained and so will the concepts. Chapters 9 & 10 describe several types of networks which are in wide use by hams.

8.A WHAT IS A NETWORK?

The "Webster's New Collegiate Dictionary" (1974) provides the following definition of a network:

> **net-work** n 1: a fabric or structure of cords or wires that cross at regular intervals and are knotted or secured at the crossings 2: a system of lines or channels resembling a network 3: an interconnected or interrelated chain, group, system <a network of hotels> 4a: a group of radio or television stations linked by wire or radio relay 4b: a radio or television company which produces programs for broadcast over such a network.

In a very general sense, personal packet stations can thus be considered a network. This general sense of networking is inherent in the very construction of packet radio. At this level, nodes are not an issue. Software (such as LanLink) in personal stations can make this happen pretty easily at individual stations. These stations can also be used as digipeaters for wide-area service but such a network requires a very high knowledge of every detail.

In the narrow sense, a network is a system of stations (called, in our case, nodes or packet switches) that are linked by radio or other methods. Nodes provide connection services. But if the node is isolated from other nodes, the connection service is local, only; if the node has no user access, the connection service is wide-area, only.

8.B WHY HAVE NETWORKS?

There are a number of reasons why networks are so attractive.

8.B.1 WIDE-AREA CONNECTION SERVICES: Users (usually) do not need to know the details of network operation or structure to reach moderately distant network points. The degree to which network details are hidden depends on the network protocol being used. There are several protocols in general ham use (NET/ROM, TexNet, FlexNet, ROSE, TCP/IP) and each hides network details to varying degrees and in varying ways.

8.B.2 ERROR CORRECTION: All of the protocols we use provide additional error correction beyond that of basic packet stations or digipeaters.

8.B.3 FAULT TOLERANCE: When reasonably well designed, networks provide some degree of equipment failure tolerance. When one part of the network fails, the network provides alternate ways of providing its wide-area connection service. Usually, the wide-area connection service continues in the presence of the failure without any special action on the part of the user (unless the failure involves either the network destination or the one-and-only way to reach the destination). The degree to which intervention is required by node operators depends on the protocol.

8.B.4 GOOD OPERATION: Lest this list of good reasons for having a packet network leave you with a "warm-fuzzy" feeling, be aware of this: the mere existence of a network does not guarantee good operation! There are quite a few technical reasons why a given network might not work well. See, particularly, section 8.D.

8.C NETWORKING NODES & SWITCHES

The terms node and switch are generally synonymous. But, generally, ROSE networks call their nodes packet switches and NET/ROM networks call their's nodes. Here, the term node will be used with the understanding that the term is intended to apply equally to those devices frequently called packet switch.

A node manages networking details. What the details are and how they

are managed depend greatly on the protocol in use.

Nodes often, but not always, provide network access to users. Sometimes, nodes are set up only for the purpose of joining two sections of a network; if there is little or no reason for user access at that point, the node operator may economize and leave out the radio for user access. In some cases, such as TCP/IP and certain other personal-use mailboxes, personal stations may also be nodes.

Nodes sometimes offer other services beyond the basic connection services. This often include bulletin boards, weather servers, etc.

Occasionally, nodes are isolated (that is, not part of a network). This may be true because of geography or it may be true because the node operator does not want it to be part of a wide-area network. In either case, such nodes can only provide local services (mailbox, etc).

8.D NETWORK ARCHITECTURE

There is a variety of network architectures in use throughout the country. Lets look at several examples which are independent of the networking software. They apply equally well to Net/Rom, ROSE, TexNet, FlexNet, or TCP/IP. There are also a significant number of networks which contain "worm-holes". These are links which are not traditional ham-radio links. They may be commercial satellite links. They may be internet links (see Chapter 15). They may be leased or "borrowed" links on commercial common carries such as AT&T, or SPRINT using cable, microwave, or optical fiber. The presence of these links does not really alter the schemes shown below. Just imagine that one of the links shown as an RF link is some other medium which has the same end-end Physical Link characteristics (see section 11.C).

8.D.1 SINGLE FREQUENCY NETWORK: One of the first networking schemes used the same frequency for users and node-to-node linking. This system is still widely used in parts of British Columbia, Alberta, Montana, Wyoming, Southeastern Idaho, parts of Utah, and Nevada (all on 145.01MHz). Northern California and Southern Oregon also have single frequency systems.

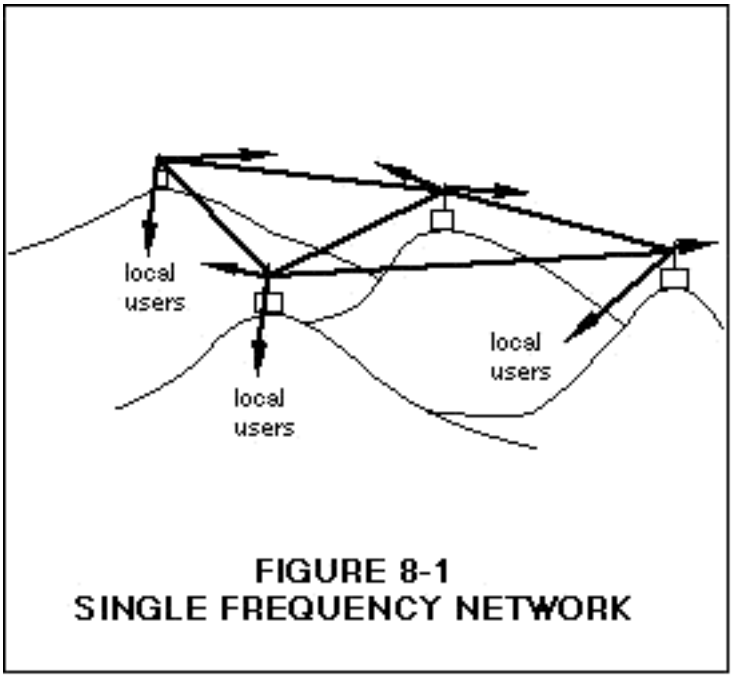

FIGURE 8-1
SINGLE FREQUENCY NETWORK

These work fine so long as the user level is low. This kind of network can, however, become easily overloaded as one node's users are hidden to the next node. Similarly, with a network which covers a very wide area as these often do, many nodes are hidden to others in the same system. Under the right circumstances (not very many users), the system does work.

8.D.2.WIDE AREA BACKBONE: The next evolutionary step and a substantial improvement over the single frequency network is the addition of a "backbone". Here, every node contains two transmitters operating on different frequencies. One is for users and one (same frequency for all nodes) is for node-to-node linking. This is shown in Figure 8-2.

Since each user frequency of each node is different, one node's users are of no importance to the next node. Congestion drops significantly. Users see a great decrease in retry rate and the time required for packets to move between nodes drops significantly.

The change to this network style usually occurs because of user pressure. And the change is usually accompanied by a rapid growth in new users (or "old" ones returning because it now works much better). In fact, there is a common belief that the single frequency systems continue to operate only because its poor performance discourages growth in user numbers! In many metropolitan areas, the growth has

been so great that even this style is no longer adequate.

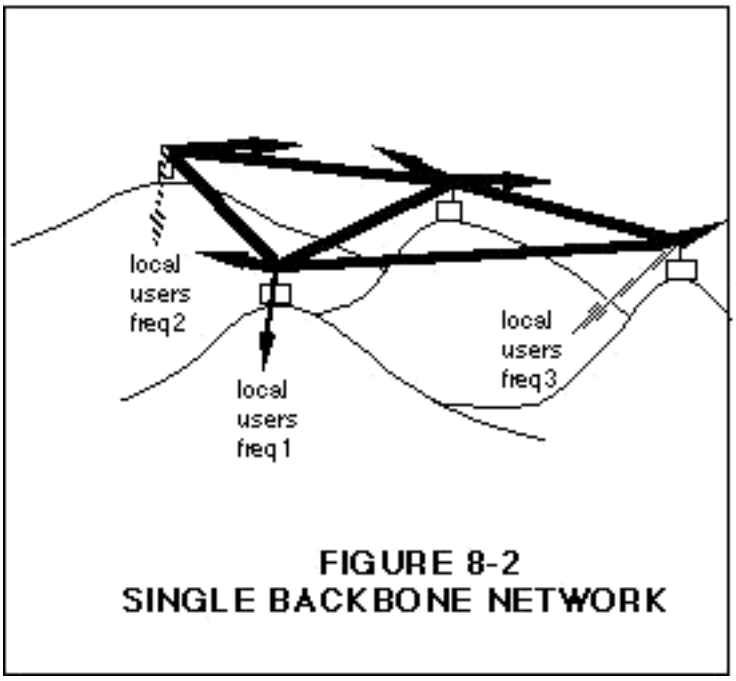

FIGURE 8-2
SINGLE BACKBONE NETWORK

What's wrong with this network? The problem is that it covers a large area on a single backbone frequency. Some parts of the network are hidden to other parts. Studies by W0RLI and others in the Portland, Oregon area have shown that the maximum number of nodes on a single frequency when BBS forwarding is involved should not exceed about 4!

8.D.3 BACKBONE "CLUSTERS": The cluster system places a few neighboring nodes on a single backbone frequency (which is a different frequency than the one used for the same purpose by other near-by nodes). The nodes on a single frequency form a "cluster". Then, another frequency (often on a different band) is used to join clusters. Figure 8-3 illustrates this arrangement.

In the Northwest, frequencies near 223 MHz (1.25 Meter band) are often used for cluster frequencies and frequencies in the 70cm band (near 430 MHz or 440 MHz) are often used for cluster-cluster linking. There is, however, no firm rule about frequencies used. In Southern California and Nevada, 50MHz band (6 Meter band) has been used. Frequencies above the 70cm band have also been used.

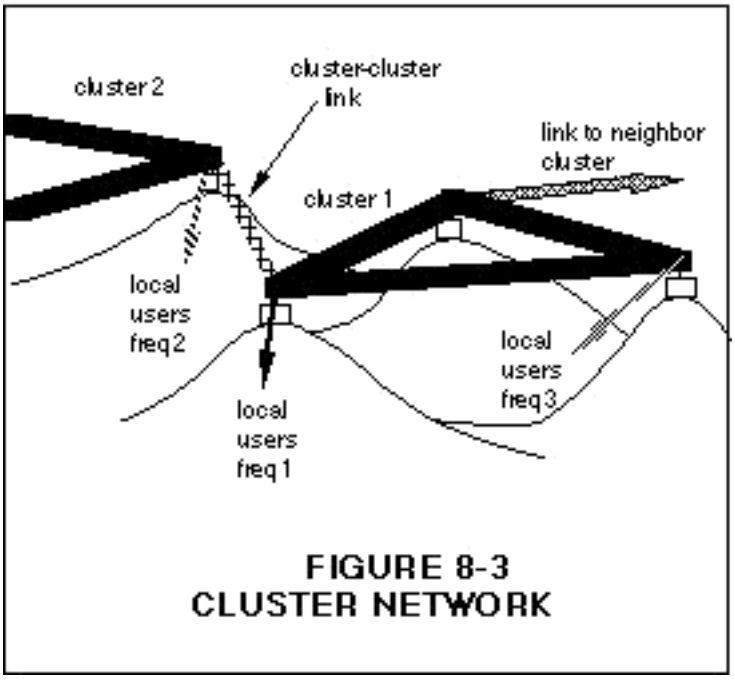

FIGURE 8-3
CLUSTER NETWORK

This arrangement requires at least some of the nodes in a cluster to contain 3 (or more) ports. Of course, this raises the cost of a node. And not all sites can provide antenna space or power for such installations.

8.D.4 POINT-POINT LINKS: As clusters shrink in number of members, the extreme case is that each frequency has only 2 nodes. The links are then called "point-point" because they go from one single point to another. This style of network is shown in Figure 8-4.

If the link is reasonably good, the retry rate drops to a very low value because there is no competition for the frequency. Directional antennas can now be used between nodes and this improves both the received and transmitted signal from both partners. Every packet which enters a node leaves on a different frequency. Of course, the cost goes up.

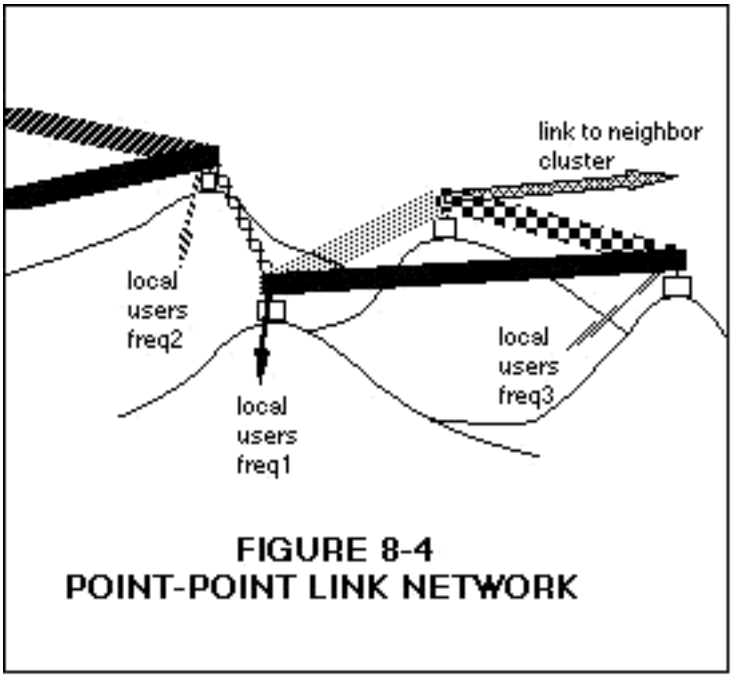

FIGURE 8-4
POINT-POINT LINK NETWORK

8.E WHAT'S IN A NODE?

Nodes are the work-horses of packet networks. It may be intuitively obvious that a node needs a radio for each frequency that it operates on. It may also then seem reasonable that an antenna is also needed (usually) for each frequency. But is is less obvious what else is required to make a node work.

8.E.1 Single-frequency TNC nodes: The simplest node is probably the single-frequency node built from a TNC. The usually preferred TNC type is the TNC2-clone. This is because the special ROM which makes the TNC operate as a node is designed only to operate in this kind of TNC. This type of node may also be called single-port.

8.E.2 Multi-frequency TNC nodes: This node arrangement consists of several single-frequency nodes joined together.

The basic arrangement is shown in Figure 8-5. It is frequently called a node-stack. This name is derived from the common arrangement for the TNCs and radios... that is, they are frequently placed on top of each other in a "stack". It is also referred to as a multi-port node.

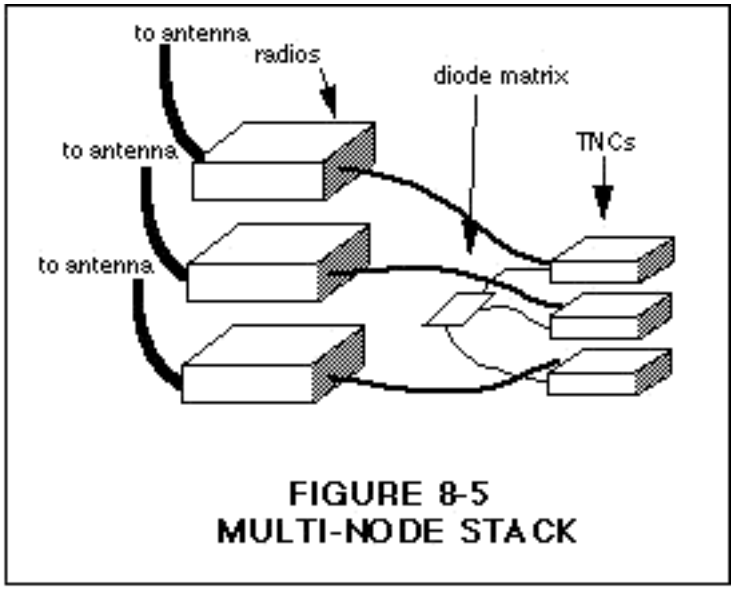

FIGURE 8-5
MULTI-NODE STACK

The connection between them is through the connector where a terminal normally is attached to the TNC. The common connection point is in a device called a diode matrix. This device keeps TNCs from attempting to all send signals to other TNCs at the same time.

The program ROMs in the TNCs are the same as in the single-frequency version.

8.E.3 Multi-frequency Computer-based nodes: This node arrangement relies on a computer to carry out the packet management and network operation. TNCs are still used but they function much more like a conventional modem. Figure 8-6 shows how such a node is constructed.

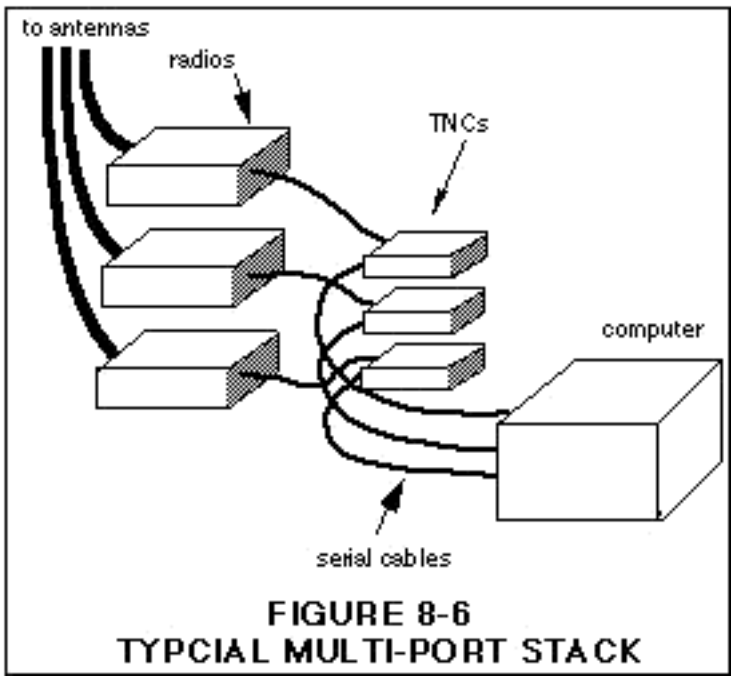

FIGURE 8-6
TYPCIAL MULTI-PORT STACK

This node setup is most commonly found with bulletin boards. The TNCs, themselves, operate in a mode called KISS (which stands for Keep It Super Simple); this mode is available in most TNCs and causes them to operate very nearly as a conventional modem.

8.E.4 Multi-frequency DataEngine nodes: This node uses a new device called DataEngine (manufactured by Kantronics). The device comes with two modems and is capable of operating to 9600 baud. Thus, by connecting two radios (of the appropriate kind) to it, a two-port node can be very easily constructed. A conventional TNC may be attached to the computer port to make a 3-frequency node and two DataEngines may be connected together to make a 4-frequency node.

8.E.5 TexNet nodes: These nodes are (minimum) two-port devices readily supporting both 1200 baud and 9600 baud. The low baud-rate port operates using standard AX.25 and the other ports use a protocol known as TEXNET-IP. Thus, on the backbone side, they are not compatible with the nodes previously discussed.

8.E.6 FlexNet nodes: FlexNet nodes are not based on TNC2s. They are referred to as RNMCs (Rein Main Network Controllers). These nodes are becoming widely used in Germany, Belgium, France, Switzerland, Austria, Italy, and Hungary. This spread is thought to be (at least partly) due to the low cost of the nodes.

RNMCs can support up to 6 ports. A 1200 baud user port is common. Like TexNet, node-to-node linking does not use Net/Rom protocol. Interestingly, this protocol is designed carry almost any other protocol wrapped inside its own. Node-node links are commonly operated at 9600 baud.

8.F SUMMARY

In this chapter, we have attempted to look at networks in a rather broad sense. We found that networks can provide wide-area connection services, additional error correction, network-level fault tolerance; but we also found that just because a network exists, there is no guarantee that it will work well!

Networking nodes manage the details of the network. Nodes can also provide access to the network for users and may also provide other services such as bulletin boards.

Networks may be arranged in a number of ways. The most rudimentary is the single-frequency system where nodes link with each other on the same frequency that users occupy. The next level of improvement is the single-frequency backbone system. Here, nodes are joined on a common frequency called a backbone while each has a different user frequency; the ability to support large numbers of users is quite a bit better for this system than for single-frequency systems. Cluster systems divide the network into smaller backbones which are joined by links on different frequencies. Point-point link systems use a unique frequency between each node and has the best ability to support many users of all of the network styles discussed.

Nodes, the key elements of networks, come in several basic varieties. The simplest is probably the single-frequency node built from a TNC with a special program ROM. Multi-frequency nodes may be constructed several ways. One way is to connect together a number of TNC-based nodes (one TNC per frequency). Another is to use a multiport controller such as a Data Engine. Yet another is to use a computer as the core of one or more nodes. Finally, special nodes may be constructed (as in the case of TexNet).

The network characteristics discussed in this chapter are independent of the protocol used. For more information about NET/ROM networks, see Chapter 9. For more information about TexNet, ROSE, TCP/IP and FlexNet networks, see Chapter 10. For the most detailed information about every node type available to the author, see Chapter 24 in Volume 2.

NET/ROM NETWORKING

This chapter and the next discuss the packet servers called nodes in more detail than the introduction of Chapter 5. The focus here is the group of node types which are based on the Net/Rom networking protocol. Chapter 10 focus on several other protocols (KaNode, TexNet, FlexNet, ROSE & TCP/IP). The goal of this chapter is to provide enough information so that you can use the Net/Rom packet network effectively. It also will attempt to convey some of the delights and frustrations of using this network.

There is quite a variety of node types which fall in the Net/Rom category. Here, the discussion tries to cover general principles of how they provide connection service. Chapter 25 in Volume 2 provides reference information about specific node implementations.

9.A WHAT IS NET/ROM NETWORKING?

The term Net/Rom is derived from the protocol developed by Software 2000 (apparently no longer in business). This protocol enabled TNCs with a different program memory (ROM) to automatically construct networks, route user connections between TNCs called nodes, and provide connection services.

Now, there are many node software implementations which use this protocol. They include TheNet, G8BPQ, MSYS, & NET/NOS (including JNOS). Networks built around this protocol cover most of the United States and Canada and are in use in many other parts of the world.

So, what is NET/ROM networking?

9.B NET/ROM NODES

Net/Rom nodes do the following things which define this protocol:

9.B.1 Neighbor list: the node maintains a list of directly heard neighbors. Neighbors are recognized by the specific pattern of their beacon. The node stores the neighbor's node name, callsign, the port on which it was heard, and number of possible routes to the neighbor. If a neighbor has not been heard in a specific time interval (called obsolescence time), the entry is removed from the neighbor list. Note that this list is adaptive and changes with changes in the surrounding network. While this results in a network requiring little manual support by the node operator (or anyone else), there are some specific problems which this process produces.

9.B.2 Destination list: the node maintains a list of possible destinations (called the node list). This list includes all neighbors plus all of the destinations which are reported by neighbors and which have an adequately high route quality. The route quality for inclusion in the node list is set by each node operator.

9.B.3 Destination list beacon: nodes beacon the entries in their node lists. This beacon is heard by neighbors and is used to construct destination lists. This shared information is used to construct routes automatically (autorouting).

9.B.4 Construct autorouted circuits: when a connect request to a distant node is received by a Net/Rom node, it begins the process of constructing a circuit to the distant node. The construction of the circuit is based on route quality which is discussed in more detail later in this chapter. Once a circuit is constructed, it becomes a pipeline for packets between the node which started the circuit and the destination node.

9.B.5 Local connection service: when a user is connected to a Net/Rom node, a connection to a local station may be requested. The node will attempt to make the connection, using the user's callsign but with the user's SSID changed to 15-(userSSID).

9.B.6 Other services: the node may provide other services. Standard services include node list, route list, and user list. In addition, bulletin board service, callbook service, etc. may be supplied (see

Chapter 5).

9.C BASIC NODE LIST

Node lists are discussed in detail in several other sections of this chapter. However, in order to interpret what is happening with route quality, we need a little bit of information about how node lists work in Net/Rom-style nodes.

The following TheNet example was chosen specifically because its node lists are small. Sending *N[ode]* causes the node to return a list of known destinations. This list may not be complete, however, because most nodes just return the names of node user-ports. For nodes in which this is true, sending *N[ode] ** causes the node to return a list of all known destinations, including backbone-port names (which begin with #).

```
n
VALLEY:N7FGF-3}  Nodes:
CRS:NV7N-14        EM4:WB6LMA-4       KENO:NV7N-2        KLMT:NV7N-1
LKV:KJ6ZP-1        MFR:WA7FAB-4       OAK:W7EXH-1        RDG:WA6YNG-1
n *
VALLEY:N7FGF-3}  Nodes:
#EUG:W7EXH-12      #EUG4:W7EXH-8      #EUG5:W7EXH-9      CRS:NV7N-14
EM4:WB6LMA-4       KENO:NV7N-2        KLMT:NV7N-1        LKV:KJ6ZP-1
MFR:WA7FAB-4       OAK:W7EXH-1        RDG:WA6YNG-1
```

9.D ROUTE QUALITY

Route quality is crucial to the routing process in a Net/Rom network. It is also one of the most confusing pieces of information available from a Net/Rom-style node.

9.D.1 NEIGHBOR ROUTE QUALITY: At each node, every directly heard neighbor is given a route quality which ranges from 0 to 255 (bigger is better). It is important to recognize that the assigned route quality may not have any relationship to the actual quality of that route at any given moment. Route quality values are assigned by the operator of the node. The node operator may choose to give all stations heard on a particular port a blanket quality value. The node operator may choose to manually assign a unique quality to each and every neighbor. Or the node operator may choose to manually assign unique route qualities to a

few and a blanket value to all of the remaining. Each of these schemes is in use in various areas and it is often an issue which brings on intense debate.

The important fact to note, however, is that the operator chooses the route quality. It is not determined by how easy it is to get packets to or from that neighbor. Thus, if antenna damage, propagation changes, or anything else alters how good a particular route is, unless the node operator changes it, the same value still applies.

Lets look at a Net/Rom style node and see how neighbor route qualities are reported:

```
SALEM:AF7S-1}  Routes:
> 3 K7UYX-1 224 8
> 2 N7IFJ-9 224 2
  1 N7HZT-9 192 2
> 2 KA7AGH-8 224 151
  2 N7TLD-8 224 4
  1 K7MYU-9 192 2
> 2 KA7UPD-1 224 57
> 3 W7VTW-11 224 44
```

For the record, this is from a G8BPQ node which uses Net/Rom protocol. This is a 3-port node and the numbers preceding the callsigns indicate the port on which each of these neighbors was heard. All neighbors on port 3 of this node share a 1.25 meter cluster and have been given route qualities of 224. All neighbors of this node on port 2 share a 70cm, 9600 baud frequency and have been given route qualities of 224. All neighbors on port 1 are on the 2 meter user frequency and have been given route qualities of 192. The remaining numbers and symbols will be discussed later in this chapter.

Lets look at another node which shows some of the other route quality issues. This one is a TheNet backbone port of a two-TNC node stack of the type discussed in section 8.E.2.

```
#ALW:WA7HJV-10}  Routes:
> 1 ALW:WA7HJV-5 255 1
  0 #BOIS3:N7FYZ-6 0 0 !
  0 WB7DOW-13 0 0 !
  0 #YKMSL:KB7HDX-7 0 0 !
  0 W7SC-1 0 0 !
  0 #HOME:KB7CFD-3 0 0 !
  0 KB7DBD-8 0 0 !
  0 K7YLO-2 0 0 !
  0 #ONO2:WB7RES-6 0 0 !
```

```
> 0 #NUKE:K7OJ-7 224 51
> 0 #PDT:N7ERT-10 224 71
> 0 #BKE:W7NYW-9 224 17
  0 #JDY:N7LZM-7 224 17
  0 #SPOKN:WB7NNF-7 224 44
```

With TheNet nodes, there are two places where a neighbor may be heard. Neighbors heard over the radio are port-0 neighbors and a zero precedes their callsign. Neighbors which are other members of the same node stack are port-1 neighbors and a 1 precedes their callsigns. Normally, other members of the same node stack are given quite high route qualities; here ALW:WA7HJV-5 is given a quality of 255. Some radio neighbors are given a quality of 224. Some others are given qualities of 0. This is done in this case because they may be heard only once in a while or, even though heard, may not have an adequate path for normal communication.

9.D.2 DESTINATION ROUTE QUALITY: It is sometimes hard to imagine how destination route quality comes about. The difficulty often arises because of confusion about what comes first. In fact, networks evolve and the route quality entries are a product of that evolution.

To see how this evolution occurs and what its result is, lets consider a very simple case. This simple case involves an isolated node named BIGTWN. Then, nearby (but not too nearby), a node named PODUNK is built to link with BIGTWN. Finally, to improve things, HILTOP is added. Lets see what happens during this progression.

STEP 1 - BIGTWN on line: We will pretend that there is a single, isolated, node named BIGTWN:NA1BC-1 (ie, Bigtown). It plaintively beacons UI packets (see section 4.D.1) from NA1BC-1 addressed to NODES. The beacon says that it is a routing broadcast (with a special character first in the message), then says "my node name is BIGTWN". It says no more because it does not know anything about any other nodes.

STEP 2 - PODUNK on line & beacons: Now, suppose that a group of hams at Podunk decide that they want to talk to their packet friends in Bigtown. So, they put up a node named PODUNK:KB2XYZ-1. Soon after being turned on, PODUNK sends a beacon very much like the ones BIGTWN has been sending. This is because, at this point, it has not yet heard from any other nodes. BIGTWN hears this beacon, and if we were to ask for a node list from it, would get:

```
 n
BIGTWN:AB7BC-1}  Nodes:
PODUNK:KB2XYZ-1
```

And if the BIGTWN node operator had set the neighbor route quality to 192 (not uncommon for this kind of network), the route list from BIGTWN would read:

```
R
BIGTWN:AB1BC-1}  Routes:
  0 PODUNK:KB2XYZ-1 192 1
```

PODUNK was heard on BIGTWN's the radio port, has a quality of 192, and knows the route to 1 destination (itself). The next beacon from BIGTWN now changes because, for the first time, it has an entry in its destination list!

STEP 3 - BIGTWN beacons: BIGTWN beacons again with a UI packet from NA1BC-1 addressed to NODES. The beacon says that it is a routing broadcast (with a special character first in the message), then says "my node name is BIGTWN". But this time, it also says "I have a route to KB2XYZ-1 which is named PODUNK. The neighbor of mine which which has the best quality route to KB2XYZ-1 is KB2XYZ-1 and the route quality by way of that neighbor is 192". The latter may be a bit confusing and a bit redundant. This is, however, the standard set of information.

PODUNK, in turn, hears BIGTWN's beacon. From that beacon, it determines that BIGTWN knows about 2 destinations (BIGTWN, itself, and PODUNK). PODUNK considers the latter a trivial route because it is a route to itself, but counts it, none the less. A user at PODUNK would then see:

```
 n
PODUNK:KB2XYZ-1}  Nodes:
BIGTWN:AB7BC-1
R
PODUNK:KB2XYZ-1}  Routes:
  0 BIGTWN:AB7BC-1 192 2
```

After the next beacon from PODUNK, BIGTWN recognizes that PODUNK also has two routes. BIGTWN's route list changes accordingly.

STEP 4 - HILTOP on line & beacons: Now, after a little use (probably not very much) the users of both BIGTWN and PODUNK discover that the route is not very good. Retry rate is pretty high (which all can see by monitoring). Somebody then notices, a little belatedly, that Big Rock Hill just happens to be directly in the path between the two. After much head scratching and discussion about whether or not it is all worth it (and, of course, it is), the two groups decide to get together and install a node part way between BIGTWN and PODUNK. This new node is HILTOP:W3AZ-1 (Hilltop) After a reasonable amount of preparation and testing, it is installed and the new network looks something like what is shown in Figure 9-1.

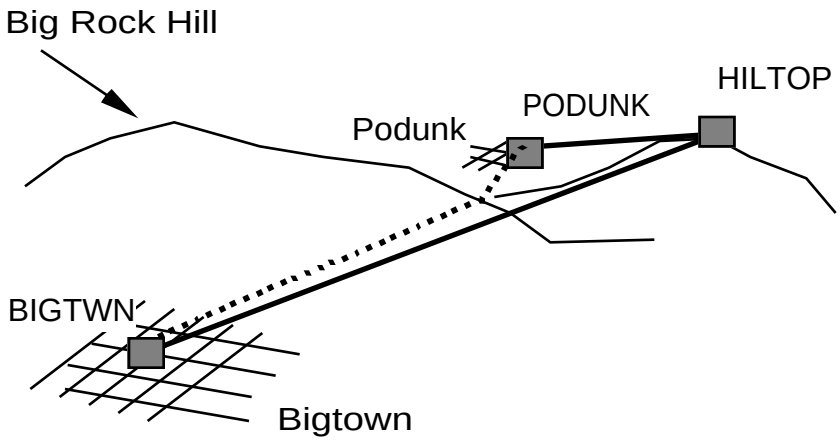

Figure 10-1
BIGTWN-HILTOP-PODUNK NETWORK

The lines in Figure 9-1 attempt to show the poor path directly from PODUNK to BIGTWN and the (expected) good paths from HILTOP to PODUNK and to BIGTWN. What happens when HILTOP goes on the air and beacons for the first time?

Assuming that HILTOP beacons before it hears either of the other two nodes, it is much like when PODUNK went on the air. The first beacon just says that HILTOP is on the air. The beacon is from W3AZ-1 and is addressed to NODES; it says that its name is HILTOP. There is nothing more because it knows nothing of the other two nodes (yet).

Suppose that users were to connect to each of these three nodes very shortly after HILTOP's first beacon. Each would see the following:

```
 n
BIGTWN:AB7BC-1}  Nodes:
HILTOP:W3AZ-1    PODUNK:KB2XYZ-1
R
BIGTWN:AB1BC-1}  Routes:
  0 PODUNK:KB2XYZ-1 192 1
  0 HILTOP:W3AZ-1   192 1

 n
PODUNK:KB2XYZ-1}  Nodes:
BIGTWN:AB1BC-1   HILTOP:W3AZ-1
R
PODUNK:KB2XYZ-1}  Routes:
  0 BIGTWN:AB1BC-1  192 1
  0 HILTOP:W3AZ-1   192 1

 n
HILTOP:W3AZ-1}  Nodes:
R
HILTOP:W3AZ-1}  Routes:
```

Note that HILTOP does not yet know anything about the other two nodes. PODUNK has now heard BIGTWN & HILTOP. BIGTWN has now heard PODUNK & HILTOP. But that is only part of the story.

STEP 5 - PODUNK beacons: If PODUNK happens to beacon next, it now has something to say. Again, the beacon is from KB2XYZ-1 and is addressed to NODES. It says that its name is PODUNK. Since it has heard from both BIGTWN and HILTOP, it says (in effect) "I know the way to BIGTWN which has the call AB1BC-1; the neighbor with the best route to it is AB1BC-1 and that route has a quality of 196. I know the way to HILTOP which has the call W3AZ-1; the neighbor with the best route to it is W3AZ-1 and that route has a quality of 196."

When BIGTWN hears this beacon, things change quite dramatically even though one will not see the effect in the node or route list. Now, BIGTWN has heard HILTOP directly and it has heard that PODUNK knows the way to HILTOP. PODUNK said that its route quality to HILTOP is 192. BIGTWN discounts this route quality according to the quality of the link between itself and PODUNK. Since it gives all neighbors a quality of 192 and 256 is perfect, it determines that the route to HILTOP through PODUNK has a quality of 192 * (192/256) = 144; the first 192 is the quality reported by PODUNK's beacon and the 192/256 is the reduction due to the quality of the BIGTWN-PODUNK link. If a BIGTWN user were now to request information about routes to HILTOP, BIGTWN would return:

```
N IHLTOP
BIGTWN:AB1BC-1}  Routes to HILTOP:W3AZ-1
  192 5 0 HILTOP
  144 6 0 PODUNK
```

Note that it shows a route quality of 192 in the direct link to HILTOP and a route quality of 144 by way of PODUNK. The significance of this difference should become obvious during the discussion of autorouting.

STEP 6 - BIGTWN beacons: If BIGTWN beacons next, it again says that it is AB1BC-1 and is named BIGTWN. It says that it has a destination W3AZ-1 which is named HILTOP, the neighbor which has the best quality route to it is (also) W3AZ-1 and the route qaulity via that neighbor is 192 (only the one highest quality route is reported). It also says that it has a destination KB2XYZ-1 which is named PODUNK, the neighbor which has the best quality route is KB2XYZ-1 and the route quality via that neighbor is 192.

STEP 7 - HILTOP beacons again: When HILTOP beacons a second time, it has heard the beacons from both PODUNK and BIGTWN. Its node list and route list are then filled:

```
 n
HILTOP:W3AZ-1}  Nodes:
BIGTWN:AB1BC-1   PODUNK:KB2XYZ-1
R
HILTOP:W3AZ-1}  Routes:
  0 BIGTWN:AB1BC-1   192 2
  0 PODUNK:KB2XYZ-1  192 2
```

The beacon is now very much like the other two beacons.

STEP 8 - FARWAY comes on line and beacons: To add a little realism to our little fable, lets now suppose that a node named FARWAY:A8ZZ-5 comes on line. It is so far away that only HILTOP can hear it. When it beacons the first time, it, like the others, simply announces it presence. HILTOP hears it and HILTOP's node and route list become:

```
 n
HILTOP:W3AZ-1}  Nodes:
BIGTWN:AB1BC-1   FARWAY:A8ZZ-5    PODUNK:KB2XYZ-1
R
HILTOP:W3AZ-1}  Routes:
  0 BIGTWN:AB1BC-1   192 2
  0 PODUNK:KB2XYZ-1  192 2
  0 FARWAY:A8ZZ-5    192 1
```

But, up to the time when HILTOP beacons next, neither BIGTWN or PODUNK know anything of FARWAYs presence. During this interval, HILTOP is the only node which knows about FARWAY.

STEP 9 - HILTOP beacons: The next beacon from HILTOP begins like all of the others. But there is now a new destination which it reports as A8ZZ-5 (called FARWAY) and the best route to it is the neighbor A8ZZ-1 by which the route is 192. When this beacon is heard by BIGTWN and PODUNK, their node lists change but the neighbor (route) list does not. For example, BIGTWN would show:

```
  n
BIGTWN:AB7BC-1}  Nodes:
HILTOP:W3AZ-1    FARWAY:W8ZZ-5   PODUNK:KB2XYZ-1
R
BIGTWN:AB1BC-1}  Routes:
  0 PODUNK:KB2XYZ-1 192 1
  0 HILTOP:W3AZ-1   192 1
```

Notice that, for the first time, there is an entry in the node list which is not also present in the route list. Suppose that, like one of the earlier steps, a user were to ask the route to FARWAY:

```
R  FARWAY
BIGTWN:AB1BC-1}  Routes to FARWAY:W8ZZ-5
  144 5 0 HILTOP
```

BIGTWN reports a route quality of 144 because it heard that HILTOP had a route quality of 192. BIGTWN reduced the route quality to that distant node then by 192/256 for the same reason as in step 5. And if asked, PODUNK would show the same route quality and neighbor which knows the way.

STEP 10 - BIGTWN and PODUNK beacon: The last step we will observe in this evolutionary odyssey is after both BIGTWN and PODUNK have beaconed. Their beacons both include this information: there is a destination W8ZZ-5 named FARWAY; the neighbor with the best route is W3AZ-1 and the route quality via that neighbor is 144. After this pair of beacons, none of the node lists change but request for the route to FARWAY from BIGTWN now shows:

```
R  FARWAY
BIGTWN:AB1BC-1}  Routes to FARWAY:W8ZZ-5
  144 5 0 HILTOP
  108 3 0 PODUNK
```

Note that BIGTWN now thinks there are two routes to FARWAY. One is via the neighbor HILTOP. The other, and lower quality one, is via PODUNK (from which the route would next to to HILTOP, also). This latter route has been further devalued to 108 because PODUNK reported that the route quality there was 144. BIGTWN then reduced that by 192/256 because of the 192 route quality between PODUNK and BIGTWN.

We might continue to track how routes and their qualities evolve as more are added to the network and as the architecture of the network evolves from this single-frequency system into a backbone system. This is enough, however, because all of the principles have been discussed.

9.E. AUTOROUTING

Suppose that a user (at BIGTWN) in our preceding fantasy were to ask to be connected to PODUNK. The routing server in the node is activated. It asks "which neighbor has the highest quality to PODUNK?". To find the answer, it scans its destination table and finds that there are two routes to PODUNK. The highest quality is directly to PODUNK with a quality of 192. The next best one is via HILTOP with a quality of 144.

The router tries to make the direct connection first. Lets suppose that it is not successful, since Big Rock Hill is in the way. There are so many retries that it fails before making the connection. Then, it tries the next best route, via HILTOP. Because the route is much better, the link to HILTOP is made very readily. Then HILTOP attempts to continue the route to PODUNK; the route to that destination is PODUNK, itself. The link is good, and the connection is readily made. As soon as all of this is complete, the originating node then notifies the user of the successful connection.

If the direct route from BIGTWN to PODUNK had not been so bad, BIGTWN might have been successful with the direct request. But what happens if conditions worsen and the link is no longer good enough to sustain operation? The Net/Rom protocol is designed to seek out an alternate route. In this case, it would attempt to remake the connection via HILTOP. Observation of this process, however, suggests that it does not work very well!

9.F. MANAGED ROUTE QUALITY

In section 9.E, we saw the consequences of route quality which does not reflect the real-world quality of routes. Some node operators take the view (with some justification) that a moderate degree of route quality management can improve the operation of some networks.

In the preceding example, proponents of managed route quality would have manually set the quality of the link from (from either PODUN or BIGTWN) to HILTOP to 192 while setting the quality of the direct path between them to, say, 120. When BIGTWN is asked the route to PODUNK (which is the same thing the router would do), it would return:

```
R  PODUNK
BIGTWN:AB1BC-1}  Routes to PODUNK:KB2XYZ-1
  144 5 0 HILTOP
  120 3 0 PODUNK !
```

Note that the exclamation mark indicates that the PODUNK route has been manually set while routes involving HILTOP take on the route quality designated for all other routes.

With this change, the route to PODUNK via HILTOP would have the highest quality and the router would always try it the first time. The poor quality direct route would only be attempted if the first one were to fail. If HILTOP were to go off the air, there would still be the direct path. There being no alternate routes, it would always be attempted as it was before HILTOP came into service.

This is a fairly modest level of management. Some would argue, however, that Net/Rom works best when it is allowed to function without human tinkering. This debate, and its variations, has no real answer and you may see versions of it arise in various situations.

9.G. THE LOST NODE PROBLEM

Suppose that one of the nodes in the previous example suddenly disappeared. Perhaps power failed; maybe it was a transmitter or TNC.

What happens to the autorouting?

There is a timeout on all the route table entries (called obsolescence counter). If no word is heard from a node in a specific time, it is removed. The problem arises before that time has run out on all the nodes. Prior to that time, a node may broadcast its node list. That list will contain the entry for the lost node because its time has not run out. That broadcast will reset the timers in other nodes which hear that broadcast, at least as far a routing THROUGH those nodes is concerned. Thus, it may take quite a while for a node entry to finally disappear.

The interim time is handled by a network parameter known as time-to-live. When a connect request is send out by a node, the time-to-live counter (contained in the packet header) is set to a predetermined value. Each time the packet passes through a node, the counter is reduced by 1. When the counter reaches 0, the node where it is simply discards it! This keeps packets from forever circulating through a network, looking for a node which cannot be reached.

To see how this works, suppose that HILTOP were to experience a power failure. Then, further suppose that shortly after this power failure, a user at BIGTWN requests a connection to FARWAY. This node is still in the destination lists of both BIGTWN and PODUNK. BIGTWN attempt to make the connection via HILTOP, without success. It finds from its destination list that the next best route is via PODUNK. So, with some difficulty, it connects to PODUNK. The PODUNK destination list shows that the best route to FARWAY is via HILTOP and it, also, tries in vain. At PODUNK, the next best route is via BIGTWN! Connections keep getting made back and forth until the time-to-live count in the connect request reaches zero and is discarded.

Suppose, now, that PODUNK makes a route beacon before the obsolescence counter of HILTOP times out. It broadcasts the fact that it has a route to HILTOP and FARWAY. At BIGTWN, the neighbor entry of HILTOP will time out but the beacon from PODUNK is newer and that one still says that there is a way to FARWAY. Thus, this entry may persist longer than HILTOP's!

9.H. WHY AUTOROUTING DOESN'T ALWAYS WORK

The previous section suggested several reasons why a connect request

to a distant node might not work. There is, however, another reason and it is quite subtle.

Suppose that you request a connection to a node which is more distant than the time-to-live number of your node? Perhaps you are in Ellensburg, WA and want a connect to SNOW (Salt Lake City, UT). There are about 9 intermediate nodes between the two. If time-to-live is set at 6, the connect request will get lost and never acknowledged! It may take a long time, if there are alternate routes (as there are in this example), for the failure message to appear. There are definite strategies to deal with this situation and they are discussed in the section 9.K.

9.I. NODE NAMES

A word may be in order concerning node names. In the U.S. West, the historical practice was to use airport/weather bureau designations. Thus, there were node names like SEA (Seattle), PDX (Portland), BOI (Boise) & SFO (San Francisco). That practice still continues. A problem arose as the number of nodes grew: there weren't enough of these names. Thus, we have names associated with geographical features (HEBO = Mt. Hebo, near Tillamook, OR and KING = King Mtn, near Wolf Creek, OR), names associated with callsigns (RLIMB = W0RLI's MailBox) and full town names (BOISE). In Alberta, A common practice is to use the prefix AB on node names (as in ABHAT, Medicine Hat, Alberta).

Another group of node names are associated with TCP/IP nodes (see Chapter 10 for more information). In much of the Western U.S., a common practice is to use a name which is the hex version of the last three sections of the stations IP address. Thus, for the node 74002C, the last part of its IP address is .116.0.44. In British Columbia & Alberta (and many other parts of the U.S.), the TCP/IP practice seems to be to use names like IPxxx or xxxIP.

9.J. ROUTE LISTS:

The route quality aspect of route lists has already been discussed in detail. Lets look now at some of the other information contained in a Net/Rom route list.

Route lists gives a list of a node's immediate neighbors. In this case, immediate neighbor means a node which it has heard first hand without intervention by any other station. An example for a G8BPQ node looks like this:

```
SALEM:AF7S-1}  Routes:
> 2 KA7AGH-8 224 109
> 3 N7DXT-10 224 30
  3 W7XI-13 224 26
  3 W7BH-11 224 12
  3 W7VTW-11 224 21
  3 KA7UPD-1 224 26
  2 N7KOJ-1 224 11
  3 K7UYX-1 224 30
  3 KA7KAJ-11 224 18
> 2 N7IFJ-9 224 2
```

The style for this list varies a fair amount with node types. See Chapter 25 of Volume 2 for details. But in this case, the neighbors are listed by callsign (some show only name, others show name and callsign). The number following the call is the route quality number. The last number is essentially the number of destinations in that neighbors destination list (all entries in the neighbor's node list, plus itself).

There is a > symbol in the first column for some neighbors. This indicates that the link to that node is in use or has been in use very recently.

The first number column has two meanings, depending on node type. If that column contains only 0's and 1's, a 1 means that the node is connected to the one you are on with a wire; a 0 indicates that it was heard over a radio. If, as in this case, there are numbers like 1,2,3, the numbers refer to port numbers and the number tells on which port the node was heard.

MSYS nodes give a route list which looks like the following. It provides headings for each column and indicates the time in hours and minutes since a route beacon was last heard from each neighbor. There is no link activity indicator.

```
r
#SRA:N7IFJ-9}  Routes:
Port   Neighbor Node Call  Quality Dests Heard
Digipeater(s)
   0      SALEM:AF7S-1      192    136   02:42
   0     WASHCO:N7TLD-8     192    130   03:26
Node cmd?
```

JNOS nodes have a route list which is like this. The style is much like MSYS with some changes, of course. There are link activity indicators. JNOS uses named ports rather than numbered ones. There are two additional pieces of information. One is whether or not the neighbor is implements G8BPQ additions to the Net/Rom protocol as shown by the (BPQ) symbol. It also shows an obsolescence count. This count is commonly set to 6 each time a routing beacon is heard and is periodically reduced; the smaller this value is, the older the information.

```
nr
Routes :
   Neighbour              Port  Qual Obs Dest
  JNOS40:WG7J-11   (BPQ) 2m     192  5    1
>    CRV:K7UYX-1   (BPQ) 2m     128  5  108
  CRVBBS:WG7J-1          2m     192  5    1
  1A0008:KB7IRS          2m     192  6    1
Area: ka7ehk >
```

9.K. WORKING OVER DISTANCES

If you can't readily connect to a node a long ways away, how can you carry on conversations over a real distance? It isn't easy, but it can work. You need persistence and a little knowledge about the network (which hopefully was provided in the earlier sections of this chapter).

You do need to be prepared for the following difficulties: unexpected disconnects, slow turn-around, networks which change, and unpredictability. Now that's an amateur radio challenge if ever there was one!

How do you do it? The first secret is to connect to nodes at intervals of 2-4 hops. This gets past the time-to-live dilemma described in the section 9.H.

The second secret is go get, or make your own, map of the part of the network you are interested in. Earlier parts of this chapter have described how you can determine which nodes are neighbors to which. Most nodes respond to an *I* command; this returns node information. Nodeops have been much better in the last few years about putting useful information here. In particular, you need to look for location information if you don't already know. You may have to rely on deduction and guesswork based on the node name if you don't get clear

help.

The third hint is to do your longer distance work when the network is being lightly used. Late at night seems to be a good choice. So do early Saturday and Sunday mornings. Best seems to be after midnight, Sunday night.

One hint which reduces the activity on your behalf in nodes is this: when you encounter NetRom style nodes with names beginning with #, they are usually backbone ports. If you are using that node as an intermediate point just passing through, connect to it instead of the user port. There is a possible trap in this strategy. One of the versions of TheNet permits the nodeop to disallow connect requests FROM the backbone port of the node to another backbone port. Fortunately, this option is rarely chosen. Unfortunately, the node does not tell you that it is refusing the request!

The author and others in western Oregon have been able to carry on conversations with packeteers throughout the Northwest using these techniques. Join us!

This chapter focuses on several network schemes which do not follow the Net/Rom rules (KaNode, TexNet, FlexNet, TCP/IP and ROSE) . Chapter 9 was devoted entirely to Net/Rom networking. The goal of this chapter is to provide enough information so that you can use these packet networks effectively.

10.A KANODES

The term KaNode is apparently derived from the manufacturer's name, Kantronics. The products first developed by Kantronics made available in a well packaged product a device which provides basic connection services. While many are used only on VHF, their real popularity has been as two port nodes on VHF and HF. These provide an access method to HF for folks who are otherwise limited to VHF. For operational details, see Chapter 25 of Volume 2.

The KaNode provides no networking capability. Thus, it is intermediate in "smarts" between the digipeaters described in section 3.C and the networking nodes described in the Chapter 9 and in the following sections of this chapter.

Most KaNodes that the author has encountered seem to be dual frequency (two port). A few are single frequency. The following description applies to both except the comments concerning cross-connection between ports.

10.A.1 WHAT A KANODE DOES: A KaNode allows you to connect to it. Then, you can ask it to connect you to someone or something else. Many also have mailboxes attached. The convention often seems to be that mailbox, node, and digipeater function have different SSID's (see sections 3.A.1, 3.B, 4.E concerning SSID's). The example of section 3.B shows, in fact, a KaNode mailbox.

10.A.2 HOW TO CONNECT THROUGH A KANODE: To connect to another node or station using a KaNode, you must connect to it first. Then, you ask the node to make the connection for you. To make a

connection on the same frequency as that on which you arrived at the KaNode, you simply send *C callsign* where callsign is either an amateur call or a node name. For example, if you connected to a KaNode on VHF and wanted to connect to W1MM who's station is in connect range and on the same VHF frequency, you would simple type *C W1MM*. The advantage of this method over using it as a digipeater is in error handling as discussed in section 3.D.

If you connected to a KaNode on HF and wanted to connect to W1MM who's station is in connect range and on the KaNode's VHF frequency, you would simple type *X W1MM*. When you wish to make a connect on the opposite frequency at that on which you arrived at the KaNode, you simply send *X callsign*. The "X" in this case means "cross-connect".

An interesting and useful feature of KaNodes is the stay-connected option. This is particularly useful on HF with its frequent disconnects. What happens with the usual link failure (due to excessive retries, usually) is that the node recognises that there is no longer a good link. It then generates a disconnect message which ripples back to the user and produces the familiar `*** DISCONNECTED` on your screen. The stay-connected option stops the disconnect at the KaNode from which you connected using this option. You make this happen by adding a space and an *S* at the end of your connect request.

10.A.3 Heard and Node lists: One of the common mysteries about KaNodes is how you find out what is there to connect to. Sending the node a *J* (for Just-heard) gives you a heard list. Depending on activity, the list may hold anywhere from a few minutes to 10 minutes of calls. Similarly, sending the node an *N* (for Nodes-heard) may give a list that is several days old in parts.

Each of the two lists (J & N) indicate which of the two ports (if there is more than one) the station or node was heard. One of the confusion factors is that the ports are often listed with a V (VHF) or H (HF). If you have worked through several KaNodes, especially HF/VHF combinations, it may be difficult to tell which side of a KaNode you entered on. There is, however, an easy way. Since you are connected to the node, it must have heard you! When you ask for the Just-heard list, your callsign is almost always the last one (the most recent heard before sending you the list). Next to your call is a symbol showing the port on which you are connected. reaching any call or node with the same symbol requires a *C* because it is the same port; any call with a different

symbol requires an *X*.

Here is an example of a "J" list from a cross-band KaNode (shortened):

```
N8HEE-3/H    03/06/93  18:11:58
K7MYU/V      03/06/93  18:12:47
N7OO-3/H     03/06/93  18:12:51
AZ/H         03/06/93  18:13:54
N2EZH/H      03/06/93  18:14:04
N0SNS-14/H   03/06/93  18:15:52
WD7I/H       03/06/93  18:15:54
SALEM/V      03/06/93  18:16:33
AF7S-1/V     03/06/93  18:18:20
KA7EHK/V     03/06/93  18:18:21
WG0N/H       03/06/93  18:18:27
WH6ANH-15/H  03/06/93  18:19:15
KA7EHK-15/V  03/06/93  18:19:22
ENTER COMMAND: B,C,J,N,X, or Help ?
```

And here is an example of a shortened "J" list from a KaNode with both ports on VHF:

```
WB7SNH/2     00/00/00  00:03:28
VE7DBZ-15/1  00/00/00  00:04:00
SPR/1        00/00/00  00:05:05
VE7PL/1      00/00/00  00:07:50
VE7PL-3/1    00/00/00  00:07:59
K7TPN-8/2    00/00/00  00:08:24
WB7SNH-15/2  00/00/00  00:10:33
VE7DIE/1     00/00/00  00:11:56
VE7DHM-8/2   00/00/00  00:12:15
PTN/2        00/00/00  00:12:41
W7LD-15/2    00/00/00  00:12:41
VE7DIE-15/1  00/00/00  00:12:47
KA7EHK-15/1  00/00/00  00:12:48
ENTER COMMAND: B,C,J,N,X, or Help ?
```

Note the difference between port symbols!

10.A.4 NOTES ABOUT HF: If you are going to use a KaNode with an HF port, take a look at Chapter 12 about HF operation.

You should also be aware that the RF baud rate is usually lower (300 baud instead of 1200) and packet lengths are much shorter. Thus packets come through in smaller chunks than you might be used to and they appear more slowly.

The "hidden transmitter problem" (see section 3.E.2) is a way of life on HF. If you are in Washington and talking to a station in Colorado, there might be stations hidden (to you) in Texas or Brazil!

There is a great variety of networking nodes (of all flavors), KaNodes, & TNCs which digipeat on HF. Operation is much less defined than on VHF. The best thing I have found is to experiment, experiment, and experiment some more!

10.A.5 NETWORK-LEVEL ACTIVITY: Despite the appearance that a KaNode is simply a sophisticated digipeater, these nodes do utilize some network-level protocol (see Chapter 11).

When a connection is requested to another KaNode, a circuit similar to that of a Net/Rom node is created. This circuit becomes a pipeline for your packets. It also has additional error correcting. This activity is entirely at levels 3 and 4 of the OSI Networking Model (see section 11.B).

10.B. TexNet Networks

TexNet was developed by the Texas Packet Radio Society (TPRS). The two areas where this type of network seems to be in greatest use is in Texas-Oklahoma-Arkansas and in Michigan. TexNet nodes are described briefly in section 8.E.5. Here, we will focus on operation and use.

The TexNet protocol hides network activity quite a bit (but not entirely) from users. Routing (that is destination table maintenance) is semi-automatic.

10.B.1 Node services: TexNet nodes provide a slightly different set of services than is customary for Net/Rom nodes. Here is the list from a TexNet node near Oklahoma City, Oklahoma:

```
L                                  = List all known network LOCATIONS
C W5ABC @ LOCATION                 = Connect to station at remote LOCATION
C W5ABC VIA DIGI1,DIGI2 @ LOCATION = Connect via digipeaters
C CQ @ LOCATION                    = Call CQ on user port at LOCATION
S @ LOCATION                       = Get statistics report from LOCATION
S Y @ LOCATION                     = Get yesterdays statistics
M (@ LOCATION)                     = Connect to the Packet Message Server
W                                  = Connect to the Weather Server
B                                  = Bye (Disconnect)
```

The Packet Message Server is a local mailbox which is programmed into the node as a mail server. When you ask for a connection to the mail server at your local node (or some other one), you are connected to the mailbox which has been pre-programmed for that node. These are generally not full service store-and-foreward bulletin boards.

The Weather Server is a mailbox which is reserved for weather information. It is typically a regional mailbox devoted to weather bulletins. The same mailbox may be programmed for use by several nodes. To some packeteers outside the region where TexNet is in use, this may seem a bit superfluous. But, within this region, some of the United State's most severe weather (tornados) are found. Very fast dissemination of weather alerts is very desirable. Thus, the Weather Server can be very useful.

One of the services which is not shown on this list is called alert. Alert is intended for emergency situations. When alert is turned on, any user who connects receives a message asking the user to disconnect unless the connect is related to the emergency.

10.B.2 Making a connection: Like Net/Rom, you must know what node a particular user uses in order to connect. And, like Net/Rom, you connect to your local node first. As far as you are concerned, the difference (between Net/Rom and TexNet) is that you do not connect to the distant node before connecting to the distant user. Instead, at your local node, you type the command:

`C usercall @ nodename`

In one complete process, your connect request is routed to the node you specified with *nodename* and that node makes the connection to the station you specified with *usercall* .

10.B.3 Routing: One of the features of TexNet is that users need not know the structure of the network. If a connection to a distant user is requested, it is naturally assumed that it will happen. How does it work?

Though not shown in the abbreviated command list (section 10.B.1), there is a routes command which returns the routing table of the node to which you are connected.

```
Network CMD ?
ROUTE

LOCATIONS served by the network are:

 173 000 000 000 000  CHOCTAW    172 172 001 000 075  OKEMAH
 162 172 002 000 075  MUSKOGE    161 172 003 000 075  MKOTST
 160 172 003 000 075  FTGIBSN    164 172 004 000 075  FAYETVL
 174 172 005 000 075  HOGEYE     175 172 006 000 075  GARFLD
 166 172 004 000 075  FTSMITH    165 172 005 000 075  CLAYTON
 176 172 007 000 075  OARSMO     046 172 006 000 075  SHERMAN
 169 172 004 000 075  TULWX      105 172 016 000 075  FLORES

Network CMD ?
```

The preceeding table may be interpreted as follows: the first column before each node name is the identification number of the node. The second column is the node number of the neighbor which has the best route to the given node. The third column is the number of hops to the given node. The fourth column is the node number of the neighbor with the second-best route to the given node. The fifth column is the number of hops via the second-best neighbor to the given node.

A quick survey of the table should show how it works. Look first at CHCTAW (the 6-character AX.25 alias for the node CHOCTAW), the node which provided the route list. It is node number 173 and there are no neighbors with a route to it (not a suprise!) Then look at the entry for OKEMAH on the top line. It is node number 172. It shows that the neighbor with the best route to OKEMAH is node number 172 and there is only 1 hop involved; one can infer from this entry that OKEMAH is a direct neighbor of CHCTAW. All other nodes in this table specify route through node 172 (OKEMAH). Thus, one can also infer from this that OKEMAH is the only neighbor (to CHCTAW)!

Further, MUSKOGE, node number 162 on the second line, is only 2 hops away and, like all of the others, must go via node 172. We can infer from this that MUSKOGE is a neighbor of OKEMAH. Since it is the only 2-hop node, it must be the only neighbor of OKEMAH.

What is not apparent from the preceeding discussion is how the routing tables are maintained. There is both an automatic route management system (somewhat like Net/Rom) and a Network Management System (NMS) which frequently (every 10 minutes) surveys nodes. If any node fails to respond, routing tables in other nodes are modified. The NMS also maintains data about retry rate, node usage, etc. Thus, routing

tables are fully automatic in the Net/Rom sense but have an have an over-riding management system which deals with wide-area routing. The NMS helps to resolve the problem of the slow propagation of network changes; the NMS makes the changes network-wide much more quickly.

10.C. ROSE Networks

The ROSE network was developed by the Radio Amateur Telecommunications Society (RATS) in New Jersey. It is even more different from Net/Rom than is TexNet. Node naming and addressing is completely different and so is the method of making a connection. As mentioned in section 8.C, the convention in ROSE networks is to refer to nodes as switches.

ROSE networks are quite wide-spread in the Eastern United States. This network extends east of the Mississippi River to the Atlantic Ocean and from New York south to about Georgia. It extends westward into Oklahoma and Texas. There are also some isolated ROSE networks. One of which the author is aware is around Edmonton, Alberta, Canada.

10.C.1 Switch services: In comparison to other networks, the services provided by switches, themselves, is very limited. Most of the services which are found within Net/Rom networks are outside of ROSE networks. It is unusual, for example, to find a bulletin board which is an actual part of the network. That does not mean that such services are missing. Instead, they just are not an integral part of the network. This is a consequence of the network philosophy rather than any deficiency in the network, itself.

One can get information about how to use ROSE switches by connecting to a local switch. The switch returns a fairly detailed message. An incomplete example follows:

```
ROSE X.25 Packet Switch Version 3.2 (930303) by Thomas A. Moulton,
W2VY
SERVING THE EL RENO METRO AREA

This ROSE switch is located in El Reno OK.  Its call is AC5C-5.
frequency is 145.07
Its address is 405262.  Its digi call is AC5C5  Connect to stations
in the El Reno area with the command:
  C CALLSIGN V AC5C-5,405262
Connect with stations in other areas by using the ADDRESS of ROSE
switch in
```

```
that area instead of my ADDRESS.  For example, to connect to
"SOMEONE" in
Pauls Valley, use the command,
  C SOMEONE V AC5C-5,405238
Switches currently available on the ROSE network include:
    Oklahoma:                          Texas:
405226--ARDMORE (WA5YOM-5)          214050--DALLAS(TEXNET) (N5BCA-6)
405238--PAULS VALLEY (WB5CQU-5)     214223--DALLAS (N5DT-3)
405248--LAWTON (WJ5Y-5)             214234--NORTH DALLAS (N5BCA-2)
405262--EL RENO (AC5C-5)            214555--ROSE NETWORK NEWSLETTER
405444--VELMA (KA5ZZI-5)            409598--CENTER (WB5RIA-2)
405732--MIDWEST CITY (K5JB-5)       409845--COLLEGE STATION (W5AC-2)
405771--SPENCER (N0ELS-5)           713453--HOUSTON (W5FCN-2)
                                    713592--CLEVELAND (W5DN-2)
    Louisiana:                      817491--DOUBLE OAK (WB5
```

10.C.2 Making a connection: The method of making a connection is, to users, perhaps one of the most distinguishing features of ROSE networks.

Unlike Net/Rom or TexNet, one does not connect to the switch in order to connect to another station. Instead, a connection request is made as if the switch is a digipeater (using "via"). This method was apparently chosen in order to conform to AX.25 connection rules which are built into standard TNCs. According to AX.25, there are only two methods of connecting: either directly to a specified callsign or through digipeaters to a specified callsign. It is possible to use UI packets to carry messages without connecting (as in TCP/IP; see Section 10.D); but without special software, doing it is not easy.

The method for connecting to another station through a ROSE packet switch is:

C callsign V localswitch,distant switch

Of course, *callsign* is the call of the station you wish to reach. *Localswitch* is the callsign of the local ROSE switch, not its name. But *distantswitch* is the name, not the callsign, of the switch where you expect to find the station you are connecting to. This format is completely acceptable to any AX.25 TNC since it fits the format of connecting through a digipeater.

It is a little confusing when you wish to connect to someone who uses the same switch as your local one. In this case, *localswitch* and *distantswitch* refer to the same switch! But different characters need to go into these two slots and both slots must be filled. For example, if one were in Houston, Texas and wanted to connect to a local user, say

W5XX, on the ROSE switch (see list, above), one would enter

```
C W5XX V W5ECN-2, 713453
```

Note that W5ECN-2 and 713453 are the same switch.

10.C.3 Packet Switch addressing: To users of Net/Rom and TexNet networks, the addressing convention used by ROSE may be rather perplexing. In concept, however, it is quite simple. Names of switches are taken from telephone practice. The first three characters are the telephone area code of the area served by the switch. The last three characters are the telephone prefix of the area served by the switch. A switch may be set up to recognize a whole set of area codes or prefixes.

ROSE developers have indicated a desire to extend the addressing mechanism to complete telephone numbers with international routing prefixes. If this comes to pass, one could theoretically connect to another packet station just knowing its telephone number.

10.C.3 Routing: As can be seen from the description of the connection process, no knowledge of network structure is needed by users. In fact, it is not only not needed but hidden.

Despite the network structure being hidden, it works much like the other networks which have been described in this chapter and in Chapter 9. There are routing tables in each switch. But these tables are completely manual. That is, it takes direct action by the node operator to change the table. Thus, if a section of the network were to fail, there is no automatic adaptability. Routing is changed to accommodate such failures only when someone notices that it has happened.

10.D TCP/IP Networks

In this section, we will focus on the network aspects of TCP/IP. For other information, see Chapter 15.

Operation of TCP/IP networks can be very confusing to someone who's packet experience is mostly with one of the other network types discussed in this chapter and Chapter 9. The entire process is different, starting with the basic exchange of packets. There are no TNCs designed for radio TCP/IP (that the author is aware of, anyway). Regular TNCs work, but only when operated in KISS mode (where a

computer does most of the real work). Thus, you cannot use generic terminal programs; you must use something like NET or NOS.

10.D.1 Packet exchanges: With TCP/IP, the familiar connection never occurs. Instead, a scheme called datagram is used. If the stations exchanging packets are local (that is, they can hear each other), each one sends UI packets (which still contain a destination callsign). These packets carry all of the message information including requests to resend error packets. The conventional AX.25 scheme uses special packets to represent each of the special conditions (information, connect, disconnect, etc); see Section 4.D for more information about packet types.

In a sense, TCP/IP uses a generic [UI] AX.25 packet for almost all transactions. All of the action is in the text portion of the packet.

10.D.2 Network architecture: As with other protocols, there is typically a local network linked with other local networks. Because of the large quantities of information often tranferred (such as program files), local network baud rates are often higher than 1200 baud; there are some local networks with baud rates up to 56Kbaud. TCP/IP networks are subject to all of the constraints discussed in Chapter 8.

One significant difference is that with the standard TCP/IP software, every station can also be a node. Thus, messages may be routed through a whole set of stations (a bit like digipeating, but with all of the error correction which nodes offer). While this operation reduces the efficiency of a local network, it does work.

10.D.3 Addressing: Addressing is discussed in much more detail in Chapter 15. The important feature to note here is that TCP/IP stations have an Internet-style (or IP) address. It consists of four numbers, each in the range of 0-255 (readers knowledgeable about the inner workings of computers may recognize these as 8-bit numbers so that the entire address is a 32-bit number).

Each TCP/IP station has an address, sometimes more than one. For hams, the first number of their address is 44. This designates the amateur network. Thus, all ham IP addresses are of the type 44.xx.yy.zz. The middle two parts of the address are generally associated with a specific physical location. The last part is associated with a specific machine. Actually, if a machine joins several networks, there is a separate address for each connection to that machine.

10.D.4 Local Routing: Routing is one of the big distinctions between TCP/IP and the other AX.25 protocols discussed so far. Suppose that you are in an area where the addresses all begin with 44.10.3 (just to pick a nearly random set of numbers). Suppose that your IP address is 44.10.3.17 and you want to send a message to 44.10.3.102. There are several ways this might happen.

You may already know that 44.10.3.102 is KA6PDQ-3 who is operating as part of your local network. In this case, the IP address and the corresponding call would be entered into a lookup table in your computer. Then the UI packets from your station will be labeled to KA6PDQ-3 and from you.

Suppose that you don't know the call of 44.10.3.102. Before sending message packets, your station needs to find the callsign of the destination station. Your station then sends a UI packet which has a special set of characters in the message identifying it as an ARP (Address Resolution Protocol) packet. This packet essentially says "is the station 44.10.3.102 out there, and if so, what is its callsign?" If 44.10.3.102 can hear your station, it will answer [again, with a UI packet] "I am 44.10.3.102 and my callsign is KA6PDQ-3." Once your station receives this response, it can begin sending packets.

10.D.5 Wide-Area Routing: Routing outside your local area takes place through a gateway. Gateway is the generic name in TCP/IP networks for a station with ports on different networks. In otherwords, a gateway is a like a node-stack (but is more general since it includes wire and other links to other kinds of networks). How routing is handled depends on the relationship between addresses and network construction in a particular area.

Suppose that a network is addressed hierarchically. This means that all stations have some part of their address the same when they use the same local network. For example, everyone on one local network might have an address 44.10.3.xx and all those on a neighboring local network might have addresses 44.10.5.xx. In this case, everyone on the 44.10.3 network would have programmed into their computers the fact that all messages destined for an address 44.10.5.xx would be sent to the gateway which has a route to that network. The gateway would have programmed how to route all of those messages to the station which is the gateway to the 44.10.5 network.

A flat network is one in which there is no relationship between network structure and addresses. In this case, there might be some with 44.10.3.xx addresses on one local network and others with addresses 44.10.3.xx on another local network. In this case, there must be individual routing instructions for every station in each of the networks!

In either case, a message destined for a TCP/IP station outside the local network begins as UI packets. The header includes the callsign of the originating station and the callsign of the gateway. The body of the message then must include the address of the destination so that the gateway (and any other stations along the way) know how to route the message.

In the case of a message destined for a very distant destination, the originating station must be programmed with the gateway to which the message is handed. In many local networks with only one gateway, the choice is obvious. Decisions are then made at various points within the network. These decisions might be of the form "all messages addressed to 44.89.xx.yy" will be directed to the neighbor handling messages to the north, etc". Since the second number in the address is often associated with states, or large sections of states, these decisions can be fairly comprehensive.

Lest one develop the opinion that wide-area routing is primarily manual, it should be said that there are several protocols developed for TCP/IP networks which perform automatic routing. One of the most widely used is RIP, (Routing Information Protocol). This involves periodic routing broadcasts by gateways (reminiscent of Net/Rom routing broadcasts). Another is RSPF (Radio Shortest Path First). The gateway software must include one or the other of these in order to make them work. This is seldom a problem with computer-based gateways but can be at hilltop sites.

10.E FlexNet Networks

The author has no first-hand information about FlexNet networks. As soon as it is possible, more information will be included.

10.F SUMMARY

Chapter 10 has investigated a number of the non-Net/Rom networking protocols.

KaNodes are included in this chapter primarily because they are not Net/Rom. But, they are also, for all practical purposes, not networking. KaNodes are connection servers in addition to supporting mail boxes. Many KaNodes are dual frequency and the version most popular with other users is the kind with one port on HF and the other on VHF. This arrangement gives VHF users access to HF which they would not otherwise have.

TexNet is a network protocol popular in Texas/Oklahoma and in Michigan. Network operation is generally hidden from users but it is possible to discern some of its structure. Maintenance of routing tables is automatic; the automatic processes is augmented by one or more stations in each network which is a routing manager. This station periodically probes the network and updates the node routing tables accordingly. The use of the routing manager speeds system adaptation to node changes.

ROSE switches utilize a connection procedure which differs entirely from any of the other nodes. One does not even connect to the node for a normal user connection. Instead, it is used as if it is a digipeater. Node names are taken from telephone area codes and prefixes.

TCP/IP uses network techniques developed for wired computer networks. They are quite different from our more common packet procedures and require special computer programs. AX.25 is still, however, the method used to carry the basic information.

FlexNet nodes are found throughout many of the countries in Europe. The author does not have sufficient information to provide operating details.

AX.25, the common amateur packet radio protocol, is borrowed from the commercial packet switching protocol named X.25. This number is simply a catalog designation for this particular international standard. AX.25 is the AmateurX.25. AX.25 differs in some important details. One of these details is that X.25 has a network master to control operation. Since this was considered unacceptable for ham use, a masterless (also called peer-to-peer) version was developed for AX.25. Also, addressing was changed to meet ham legal requirements.

11.A WHAT IS A PROTOCOL?

The author's "American College Dictionary", 1957 edition, defines protocol as:

> **pro-to-col,** *n.* **1.** an original draft, minute, or record from which a document, esp. a treaty, is prepared. **2.** a supplementary international agreement. **3.** an agreement between states. **4.** an annex to a treaty giving data relating to it. **5.** the customs and regulations dealing with ceremonies and etiquette of the diplomatic corps and others at a court or capitol.

Definition 4 comes perhaps the closest to the current technical usage of this word. A useful way of thinking about it might be to think about sports. Sports protocol is what is written in the referee's rule book. But in each sport, there is also a lot tradition. In U.S. football, for example, there are the cheerleaders, the equipment, the coaches & trainers, and so forth. Most of this is not written about in rules books but is, none the less, part of the sport.

So, also, is it in amateur packet radio. AX.25 is the formal name of the protocol but there are a lot of other things which are thought of as packet radio which really are not part of the AX.25 rule book.

Actually, AX.25 defines only a very small portion packet operation. We will see how small a portion it is and how it fits with many other parts which are often not formalized or agreed on.

11.B. THE "LAYER" MODEL

There is a model (a way of visualizing) which is becoming popular in networking. It is called the ISO OSI Reference Model. ISO stands for International Standards Organization. OSI stands for Open Systems Inter-connection. Many refer to this as simply The Layer Model. It is really a framework or outline to which digital data transmission systems can be fitted. Some schemes fit this model pretty well and some, not so well. AX.25 is not too bad as long as it is recognized that it fits only a small part of the model. There is a diagram which is usually used to illustrate this model. It is shown in Figure 11-1.

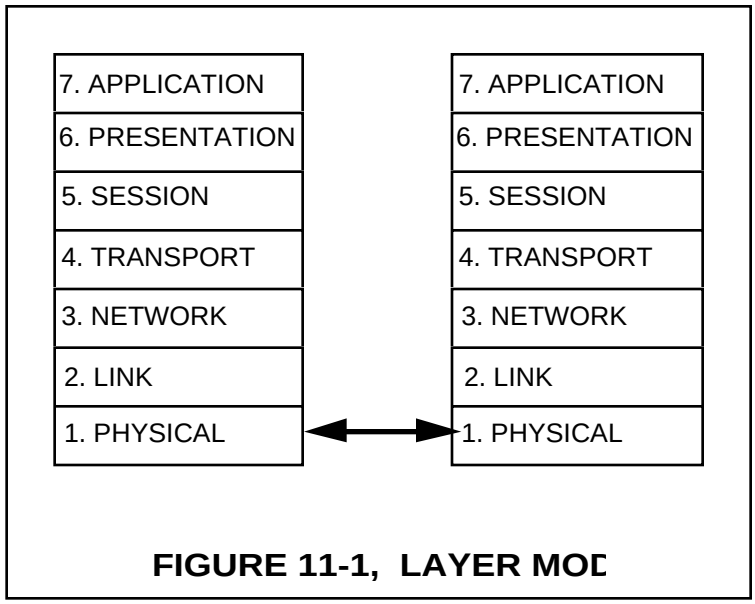

FIGURE 11-1, LAYER MOD

The layer model is important because it defines a way of organizing the computer programs which do packet radio (a TNC is, after all, just a special-purpose computer). When the programs or processes are organized this way, we start to see that:

(a) a Physical Layer does not "care" what the "bits" represent; it simply provides a mechanical means for moving those bits from one place to another.

(b) a Link Layer does not "care" how the bits are moved. It simply constructs the packet and hands it to the Physical Layer for movement.

(c) The Network Layer does not care how links are established. It tells the Link Layer to make a connection. It has a standard message format which it hands to the Link Layer for sending.

(d) Each higher layer, where it is implemented, simply passes the message to the next lower layer, expecting that that layer will move it. And that layer, passes it to the next, expecting the same, until it reaches the Physical Layer where it finally gets moved. The same happen in the opposite order at the receiving end.

11.C. A LAYER MODEL STORY

In several earlier chapters, primitive telephone systems where used to simplify the ideas of connections and routing. Here, we will use another metaphor - a pair of mythical, not-too-long-ago, armies - the Grey Army and the Light-Black Force (that's right, they are difficult to tell apart). These armies have been at war for some time for control of the region where they live. Lets zoom in on one portion of each army, the Grey Message Corps and the Light-Black Dispatch Service. Please accept my apologies about the male-only characters in this little story but in this time not-too-long-ago, almost all soldiers were male!

11.C.1 Runner-Privates: These armies (being somewhat long ago) used runners (Privates, of course) to carry messages between units. Now, these runners really do not care what the message is. They care, thought, about some pretty fundamental things, like - is it small enough? - does it have far go? - is it very heavy? In this, the two armies are really no different.

11.C.2 Command-Post Corporals: In both armies, Corporals are in charge of getting messages moved between command-posts. Corporals in adjacent command-posts have to agree on how messages are to be exchanged.

The Grey Message Corps has chosen a rather elaborate system of message pouches. They have agreed that green pouches are to be used to make initial contact between neighboring command-posts. Red pouches are to be used to end contact. White pouches are for general messages. Yellow ones are sent back to the post which sent a pouch when a white (information) pouch arrives so badly damaged that a new

one is needed to replace the original. The pouches have a handy place on the outside for writing where it is from and where it is going to. The white (information) ones also have handy numbers so that the destination can tell if any have been lost. The Corporals, of course, are responsible for writing the destination and origin information on the labels on the outside of each pouch.

The Light-Black Dispatch Service, on the other hand, has chosen to make it as simple as possible for the Corporals. There are no fancy colored pouches here! There are just some nondescript beige ones which have a label for the origin and destination. The Light-Blacks have decided that they will just send messages without all of the business of making and terminating communications.

We now have the two foundation layers for a pair of mythical communication systems. The Greys use theirs like this: The Corporal in command-post Charlie is told by his Sargent that he had better start sending plans (for tomorrow's action) to their neighbors to the north, command-post Bravo. The Corporal gets out a green pouch, and writes on the outside "to Bravo from Charlie" and gives it to a runner. The runner, having been told to go north to find command-post Bravo, sets out. But part-way there, he steps on a land-mine and is never heard from again. The Corporal at command-post Bravo does not even know that anything has happened except for the dull thud off to the south when a land-mine went off. The Corporal at command-post Charlie waits for a reply and, when none arrives, decides that it is necessary to try again. So he gets out another green pouch, addresses it again, and sends off a new runner. This runner makes it to command-post Bravo and hands it to the Corporal there. This Corporal does not have to look in the pouch; he sees that it is green, that it is addressed to his command-post, and that it is from command-post Charlie. He gets out a brown pouch (agreeing to begin exchanging messages) and addresses it to command-post Charlie from Bravo. A runner carries the pouch back, thus signaling that it is ok to proceed. Once this exchange is complete, the Corporals at each command-post tells his Sargent that the message can proceed.

On the other side of the line, the Light-Black Sargent of Dispatches at command-post Beta decides that it is time to send a message with tomorrow's plans to command-post Alpha. He simply gives the message to his Corporal with the instructions to send it. The Corporal places the message into a convenient beige pouch, addresses the pouch, and passes it to a runner with directions. The Corporal makes no decisions about

success or failure of the message exchange; that is the responsibility of his superior officers!

There is more than just a difference in style here. The Greys, being populists, believe in making decisions at as low a level as possible. Thus, their Corporals are given lots of responsibility. The Light-Blacks, on the other hand, are believers in centralized decision making and choose to make as simple as possible for their Corporals.

11.C.3 Command-Post Sargents: In both armies, Sargents are responsible for managing links with neighboring command-posts. Of course, how they go about it differs in the two armies.

The Greys think of the communication system among command-posts as a network. The Sargents are responsible, among other things, for determining which neighboring command-post to send a message which is really going to a location many command-posts distant. For example, command-post Charlie may have a message for command-post Zulu. The Sargent, who keeps track of such things, knows to send messages for Zulu to the neighbor Romeo, because Romeo sent out a general bulletin not long ago that it has a way to send messages to Zulu. When command-post Charlie wants to send a message to Zulu, the command-post Message Corps Sargent instructs his Corporal to send a special message to command-post Romeo. The Corporal, of course, does not care what the message is but it will request Romeo to "set up a circuit" to Zulu. When the Corporal receives this message, he first goes through the exercise of establishing communication with command-post Romeo, its neighbor to the South. This is done, if you will recall, by exchanging colored message pouches. Once communication is established, the Corporal at Bravo tells his Sargent that it is possible to proceed. The Sargent gives the "set up a circuit" message to his Corporal who places it into one of his (white) pouches and sends it off to Romeo. When it arrives successfully at Romeo, the Corporal there removes the message from the pouch and passes it to his Sargent. The Sargent says, "Hey, we can send directly to Zulu!" So he, in turn, writes a "set up a circuit" message and directs that it be sent off to Zulu. He passes it to his Corporal who goes through the same process, but this time with Zulu. Once established, a message goes back to Bravo, saying that the circuit is established. The Sargents in the three command-posts (Bravo, Romeo, and Zulu) control this circuit. The Corporals take care of the sending details and the Privates run the messages between the command-posts.

Light-Blacks, on the other hand, have a slightly different concept of their network. The Sargents keep a list of where to send messages for different destinations. In some cases, it is based on best guesses. In other cases, it is based on the last time the Sargents of the Light-Black Dispatch Corps got together for one-too-many beers. These lists are often kept on rumpled scraps of yellow sticky-pad which sometimes fall off the wall where they normally hang. So it is when the Sargent at command-post Beta finds that it is necessary to send a message to command-post Omega. He finds one of his pieces of yellow sticky-pad; it has written on it that messages for Omega should be sent to command-post Rho. He addresses the message to Omega but tells his Corporal to send it to command-post Rho. The Corporal puts the message into one of their beige pouches and sends the runner on his way. When it arrives at command-post Rho, the Corporal there passes the message to his Sargent, as every good Corporal should. The Sargent sees that the message is really addressed to command-post Omega so he gives it back to the Sargent with instructions to send it on to Omega. The Sargent does not know that this message is the same one he just received; to him, it is just another message and he sends it on its way.

11.C.4 Command-Post Lieutenants: In both armies, Lieutenants keep track of message movement reliability. They attach various checks to the messages received from their superiors. These checks are then used at the other end to verify that messages are received in the right order and without error. In principle, the checks are quite similar in the two armies. They choose to do them just a little differently but the differences are small enough that we need not examine them in detail.

What is important is that the Lieutenants receive messages from their Captains, add the error-checking to them, then pass them on to their Sargents for sending. On receiving a message, the Lieutenants remove all of the extra error-checking and pass the clean message up to their Captains. Their superiors need not know anything of message passing problems, it is all hidden from them.

11.C.5 Command-Post Captains: In both armies, Captains are responsible for managing message-passing sessions. In other words, this means that if there are messages are moving several ways at a time, the proper message gets sent toward the right destination. These captains are also responsible for handing messages from their Captains to their superiors, the Majors.

11.C.6 Command-Post Majors: In both armies, Majors deal with presentation of messages. In both cases, the messages may be rewritten on standard message forms. However, the forms are only vaguely similar in the two armies. But in each army, the forms are easily recognized.

11.C.7 Command-Post Generals: In both armies, the Generals being like Generals, the world over, are directors of action or application. In some cases, the Artillery Generals are interested in sending and receiving special messages of importance to their artillery units. So their messages have information about targets, winds, and such. The Airplane Generals are interested in things like targets, anti-aircraft batteries, and storms. The Supply Generals are interested in things like food, cots, boots, and spare bayonets. The standard messages are a little different for each and, of course, the two armies do things a bit differently. But the principle is that a General is responsible for each application.

When a General, say the General of Supply, wishes to send a message to another General of Supply, he passes it to his Major who makes sure the message has been written on the proper form. He then passes it to his Captain who begins a new session (if this is not a continuation of an existing one). He, the Captain, passes it to his Lieutenant who adds the necessary error verification. The Lieutenant then passes it to his Sargent with instructions for sending. The Sargent, as described earlier, goes through the actions appropriate for his army, to get it sent. At the other end, the message ripples back up through the chain-of-command to the General of Supply who can do something with the message.

11.C.8 Cutting through red tape: The Greys, particularly, seem burdened by lots of red-tape, especially in making and breaking communication with other command-posts. But every once in a while, a different runner arrives. This runner is from the "Grey News", the newspaper serving the the populace which supports the Greys. Being civilian, the Grey News folks want to get to the real source of the news, the General. As a concession to their supporters, the Grey Message Corps has made it possible for the inquiries from the News to bypass all of the Lieutenants, Captains, and Majors, and go directly to the General. This makes for much better local support and still allows the Grey Army to (generally) do things the way they want to.

11.C.9 Comments: These two "armies" represent the AX.25/NetRom and the TCP/IP world. If there is any question, the Greys are the NetRom folks and the Light-Blacks are the TCP/IP people. Each

command level corresponds to one of the layers in the Layer Model.

11.D. AX.25 & THE PHYSICAL LAYER

The physical layer describes the physical mechanism for getting "bits" from one place to another. THIS IS NOT PART OF AX.25! We are left to our own devices for moving those bits. But, over the years, a whole set of customs has grown up and they have come to define how those bits get transported from one place to another.

For example, the use of BELL-202 modem tones (1200Hz and 2200Hz) as the standard tones for AFSK modulation is the standard for VHF. On HF, the standard tones are 1600Hz and 800Hz. AX.25 never refers to this. Likewise, we tend to think of AFSK as standard. However, a modulation scheme called biphase is used on many of the packet satellites. Packet satellite modems are available for many of the TNCs with modem disconnect headers (see Vol 2-CH22: Connecting TNCs to Radios for other comments about modem disconnect headers). Similarly, direct FSK is commonly used at baud rates above 2400.

It is clearly up to system builders to define the physical layer characteristics for various parts of packet systems. It should also be fairly clear that that once bits get moved through a physical layer, it should make no difference to other layers how the bits were moved. Likewise, to the physical layer, it makes no difference what the bits represent.

11.E. DATAGRAMS AND VIRTUAL CIRCUITS

At lower levels, one of the biggest distinctions between AX.25 and TCP/IP is the use of datagrams as compared to virtual circuits. We should not, however, limit our investigation to TCP/IP because ROSE and TexNet (see Chapter 10) both use datagram-based communication for movement of packets between nodes or switches. Here, as elsewhere in this book, the term Net/Rom will be used to refer to Level 3 and Level 4 for AX.25; this term should be understood to apply equally to G8BPQ, TheNet, JNOS, and MSYS nodes.

11.E.1 Virtual Circuits: In a Net/Rom network, a link between nodes

(whether immediate neighbors or not) is set up and tested (by the nodes, themselves) before passage of user information proceeds. Once established, there is error-checking between the end nodes.

To clarify this a little further, suppose that a user is connected to a node named PODUNQ. She wishes to talk to a friend at a node names WAYFAR. In between, there are nodes named (in order from PODUNQ) HILTOP, BIGCTY, MOUNT, KNOLL, VALLY, & CENTRL. Because of the way this network happens to be set up, our user as PODUNQ cannot just type "C WAYFAR" and have a successful link. Instead, by experimenting, she has found that it works pretty well if she types, instead "C BIGCTY", then "C KNOLL", then "C WAYFAR".

When the connection request to BIGCTY is made, a circuit is set up from PODUNQ through HILTOP to BIGCTY. This is the first of three circuits which are generated. Until the circuit is broken (by a link failure or a disconnect request), error checking and correcting happens between PODUNQ and BIGCTY. Once the connection to BIGCTY is made, the connection request for KNOLL is acted upon by BIGCTY. It sets up a circuit from BIGCTY through MOUNT to KNOLL. This is the second circuit. Error correction now also happens between BIGCTY and KNOLL. Once the connection to KNOLL is made, the connection request for WAYFAR is acted upon by KNOLL. It sets up a circuit from KNOLL through VALLEY and through CENTRL to WAYFAR. This is the third circuit. Error correction now also happens between KNOLL and WAYFAR. Recognize that the error correction referred to in this paragraph is on top of the packet-by-packet error correction which is built into Level 2 of AX.25. The circuits of the kind referred to here are called virtual circuits. Note that there is no mention here of how one node knows which neighbor to use for a circuit to another node which is not a neighbor; that is also part of the Net/Rom protocol but does not relate in any way to the issue of circuits vs. datagrams.

11.E.2 Datagrams: In TCP/IP networks and the other networks mentioned previously, datagram message transfer occurs. Lets suppose that our previous example of nodes PODUNQ, HILTOP, BIGCTY, MOUNT, KNOLL, VALLY, CENTRL, & WAYFAR are part of a datagram network. Lets further suppose that this network is like TexNet such that users can connect to the nodes in AX.25 style but that datagrams are used between the nodes.

The first notable difference between this network and the Net/Rom one just described is the method for setting up the link between PODUNQ

and WAYFAR. The way these networks are set up means that the intermediate connections are not likely to be needed. PODUNQ simply sends off the first information packet to HILTOP. The packet is addressed immediately to HILTOP but it also contain characters which say the final destination is WAYFAR.

HILTOP sends it on to BIGCTY. To do so, it changes the immediate address of the packet to BIGCTY without changing the final destination. Each packet has not only the user information and final destination but other characters added by PODUNQ. These characters are for error correction by WAYFAR. If some packets arrive at WAYFAR damaged or some are lost, it is up to WAYFAR to request a repeat of those packets.

If one of the nodes in unable to deliver a packet to the next node in the chain, one of several things might happen, depending on how the network is designed. In some systems, the user might never know (except for missing notification of receipt from WAYFAR). In other systems, the user could be notified by the node which could not move the packet onward. It might, however, take some time.

BBS-to-BBS mail forwarding is in datagram style. Mail is forwarded from one BBS to another. It may take minutes, hours, or days to move from one to the next. The sender is never notified of this fact. Nor is the sender notified if one of the BBSs has a computer crash and the message is lost. Delivery is determined only if the addressee happens to send a reply (which our social protocol does not demand).

In datagram packet transport, the reliability depends on cooperation between the two end-points in the exchange, not on the system in between. It's not that efforts to produce a reliable transport system are useless. It is simply a recognition that no network likely to be built is perfectly reliable.

11.F. SOME EXAMPLES OF PACKET PROTOCOL

Lets now look at how some of these protocol ideas and the Layer Model, in particular, actually fit some of the things we experience as packet radio operators.

11.F.1 Operating with a TNC & Terminal: Basic packet operation with a TNC or its equivalent is probably the single most common packet radio activity. A TNC takes care of Layer 2 and part of Layer 1 of the Layer Model. The TNC defines the structure of a packet and the connection procedure to other AX.25 stations. The TNC also defines a lot of the characteristics of the modulation used by Layer 1. The radio defines whether the modulation is FSK or AFSK, & whether it is Single Side Band or Frequency Modulation.

For all practical purposes, none of the higher layers are present. The TNC simply delivers text characters to the terminal which displays the characters. The TNC receives characters from the terminal moves them directly to Layer 2.

11.F.2 Operating with a TNC & Advanced Terminal Software: Advanced terminal software such as LanLink and KaGold provide some of the features of higher Layers. The layers in between are missing, however. Still, the ability to manage sessions & move mail automatically should not be discounted.TNCs with auto-forwarding mailboxes fall into a similar category.

Use of software with file-transfer procedures (X-Modem, Y-Modem, Z-Modem, Kermit, YAPP, etc. see Chapter 14) have some of the upper layers managed within these procedures.

11.F.3 Net/Rom-type Nodes: These nodes have (at least) three modes of operation. One provides through-routing for circuits between other nodes. When operating in this way, only Layer 1, Layer 2, Layer 3, and Layer 4 are used. All 4 of these layers are implemented within the node software.

When a station is connected to a node directly as a local user, the low 2 layers are used. If the user asks for information from the node (such as a user list), the request is passed to higher layers which provide the response. Each such connection is a session.

If a local user requests a connection to another node or if a distant user connects through network links, then, at the very least, Layer 3 and Layer 4 come into play.

11.F.4 BBS with Node Shell: These stations have, perhaps, the most complete and obvious implementation of the full layer model. Layer 1 and Layer 2 provide the physical link to other local stations. Layer 3 and

Layer 4 (which rely of course, on the lower layers) provide network linking. Each connection to the bulletin board represents a session. Each session is capable of doing very close to the same thing, to all appearances simultaneously. The display of information including prompts, message lists, and the messages themselves, are all part of Layer 7, the Application Layer.

11.F.5 TCP/IP Stations: These stations, whether a user station or a BBS, have a similar layer implementation. In general, however, more of the layers are operating in the typical TCP/IP home station than they are in a standard AX.25 station. Because of the protocol differences, the software built into a standard TNC must be bypassed. Other software often present in a TNC (called "KISS") is used. This software permits the computer connected to the TNC to make the TNC do what the computer wants, rather than what the TNC wants.

11.G. PACKET PROTOCOL SUMMARY

The concept of a packet protocol is not particularly easy to explain. One way of visualizing the idea uses the ISO Layer Model. This model describes a (digital) communication system in the form of independent processes. The lowest level one is responsible for moving bits from one place to another without regard to what the bits mean. Then next layer describes how the bits are organized (in our case, into packets). The next two layers describe the methods by which stations are linked together into a network. In all, this model has 7 layers. The situation where the layering is perhaps the most obvious is in a bulletin board (BBS).

There are two common protocols used by hams for moving packets. One is AX.25 protocol which describes how connections are made, information is passed, and connections are broken. The other protocol is TCP/IP which uses a method without connections (called datagram or connectionless packets).

Perhaps you have just gotten yourself a new HF radio and have an urge to try packet on the lower frequency bands. Maybe you have a Technician class license and want to try packet on 10 meters. This chapter attempts to provide information for you to get started without making too many big errors.

The author is not an expert on HF packet. He has operated on HF through some VHF/HF gateways (but that is not quite the same as doing it directly on HF). Tom Rickert, N7CPA, has been indispensable in providing much of the information which appears here.

12.A EQUIPMENT

Equipment, of course, is one of those subjects of endless ham conversation. This section will avoid specific brand-name recommendations and try to provide some general guidelines.

12.A.1 Radios: A radio is a radio, isn't it? Well, yes and no. There are some general characteristics which make some radios more suitable than others for packet use. Lets consider some of these.

Stability is very important. Very few older non-synthesized radios are adequate in this department.

Smooth tuning is important. 10 hertz or finer tuning step size makes things easier.

An auxiliary jack on the rear of the radio is handy. But a caution is in order. Many newer radios permit packet access though the auxiliary jack while the microphone attached to the front of the radio. This permits simple up/down tuning at the operator's fingertips with control buttons in the microphone. But, with many of these transmitters, when the transmitter is keyed, the transmitter accepts (and transmits) all input signals. Thus, the transmitter can transmit both packet tones and microphone audio at the same time. As a result, if you are not careful, a connected microphone can transmit room sound along with you packet

tones!

12.A.2 TNCs: Are there special TNC requirements for HF operation? Yes! And No! If you are going to operate on 10 meters only, operation with VHF settings is permitted (that is, 1200 baud rf data rate). In this range of frequencies, you can use your VHF TNC.

For operation on frequencies lower than the 10 meter band, you need a TNC which provides 300 baud and the standard tones used for HF operation. This need not be a multi-mode controller unless you also wish to operate RTTY, AMTOR, etc. There are a number of TNCs which provide this capability. Appendix 2 (in Volume 2) provides some detailed information.

One TNC feature which simplifies HF operation is a tuning indicator. While this feature is certainly not necessary, it does remove a lot of the frustration, especially when you are beginning.

12.A.3 Terminals: There is no reason for there to be any difference between the terminal you use on VHF and on HF. There are, however, terminal programs which simplify the change between VHF and HF. See Appendix 1 (in Volume 2) for some suggestions in this regard.

12.A.4 Antennas: Section 3.E discussed antennas on VHF. In general, the same can be said on HF.

Directional antennas provide gain and reduced noise but cause some stations to be hidden from you. Non-directional antennas require no rotating and are good in any direction but sometimes provide weaker signals.

12.A.5 Station Layout: Section 4.L discussed station layout. Several points deserve emphasis here.

Computers and TNCs create spurious radio signals. These signals tend to get stronger as you get closer to the actual operating frequencies (of the computer and TNC). Thus, you can expect some of these to be bothersome on HF. Careful grounding of equipment may help significantly in this regard.

Transmitter output powers tend to be higher on HF than VHF. 100W or more is not uncommon. This may, in some situations, make a computers and TNCs more susceptible to interference from your

transmitter. Experience has shown that use of an elevated beam antenna usually produces fewer problems. But antennas with sections which are near ground level (such as "slopers") are quite capable of delivering interfering signals to video displays, computers, and TNCs.

12.B TNC SETTINGS

RF baud rate was just mentioned as a TNC difference between HF and VHF. There are also several parameters which are set usually differently on HF than they are on VHF.

PACLEN is usually set much lower on HF. Values of 30 are often recommended but common practice and experience suggests that values near 60 are quite adequate. With a packet header of 25 or so characters which are not counted as part of the packet length, the efficiency of a packet containing only 30 information characters is quite low.

RETRY values are usually increased on HF. A full 15 retries may not be enough! For TNC2s, *RETRY 0* causes the TNC to take as many retries as necessary and many users take this route. While the impact on a busy frequency is not very desirable, it is up to you to determine whether or not this is justified in your case.

12.C FREQUENCIES

Packet on HF in the United States is limited to frequencies denoted as DIGITAL by the Federal Communications Commission. The general practice has been that on each band, the RTTY-like signals (RTTY, AMTOR, etc) occupy the lower half of each digital sub-band and the packet-like signals occupy the upper half.

Not all nations recognize the same frequency conventions. Even if there is a packet signal somewhere else (where you are licensed to operate), you may not have the right to operate packet there.

12.C.1 1200 Baud: operation is permitted only on 10 meters. The frequency range in which the FCC permits operation is 28.190 MHz to 28.205 MHz.

12.C.2 300 Baud: operation is permitted on each of the HF bands from 10 meters down to 160 meters (including the newer WARC bands).

12.C.3 H.F Packet Band Plan: The following is the packet band plan recommended by American Radio Relay League. Along with the frequencies are noted some of the common usages.

10 METERS 28.101 300BD
28.103 300BD
28.105 300BD
28.107 300BD BBS FORWARDING
28.109 300BD BBS FORWARDING
28.111 300BD BBS FORWARDING
28.190 1200BD BBS FORWARDING
28.195 1200BD
28.200 1200BD

12 METERS: NO ESTABLISHED BAND PLAN

15 METERS: 21.100 & below; BBS FORWARDING
21.101 300BD
21.103 300BD
21.105 300BD
21.108 300BD

17 METERS: 18.101 300BD
18.103 300BD
18.105 300BD
18.107 CLOVER OR PACTOR
18.109 CLOVER OR PACTOR

20 METERS: 14.000 & below , FORWARDING; AMTOR,RTTY,PACTOR KYBRD
14.101 300BD
14.103 300BD
14.105 300BD
14.107 300BD FORWARDING (SOME KBRD)
14.109 300BD FORWARDING ONLY
14.111 300BD FORWARDING ONLY
14.113 300BD FORWARDING

30 METERS: 10.141 300BD
10.143 300BD
10.145 300BD
10.147 300BD FORWARDING
10.149 300BD FORWARDING

40 METERS: 7.100 AND BELOW BBS FORWARDING
7.101 300BD (SOME FORWARDING ON)
7.103 300BD (ALL 40 METER FREQ BUT)
7.105 300BD (BUT GOOD KEYBOARRDING)
7.108 300BD

80 METERS: 3.610 TO 3.616 300BD

160 METRS: NO BAND PLAN

12.D OPERATING PRACTICES

Single Side-Band (SSB) is used on all HF bands. The lower sideband is used even though voice communication may use different side-bands on different frequencies.

Propagation changes for packet the same way it does for other modes. Do not be surprised at the sudden loss of a link.

On HF, there are many transmitters which are hidden from you. The may be hidden by virtue of your antenna directivity. They may also be hidden because of propagation. In other words, your conversation with a station in Europe may be interfered with (not intentionally of course) by stations in Africa or Asia which you simply cannot hear but which the station at the other end can.

While tuning indicators can be very helpful as can frequency lists, the proper tuning criterion in the end is best copy. The TNC tuning indicator should get you close; usually you can trust it. But some-times, you may find that tuning up or down a very small amount may reduce retries and the best on-screen copy.

You may occasionally find signals which sound like very good packet signals and produce very good S-meter readings. A tuning indicator may, however, show erratic response or no response at all. This is thought to be the result of multi-path in which the signal arrives after following two different routes. These routes may be around the earth in opposite directions. They may take a different number of bounces between the earth and the ionosphere. But in either case,the result is the same; there are two signals which interfere with each other. Sometimes a directional antenna may help sort out the signals.

Do not use RIT or filter shifts which are available in some transceivers.

On HF, CQ is sent by placing the TNC into converse mode, then just type *CQ CQ DE yourcall.* This will be sent as a UI frame and anybody monitoring will see it. If you also have *UNPROTO CQ* set, the UI frame will be addressed to the callsign CQ.

12.E KANODES ON HF

KaNodes and digipeaters are quite frequently used on HF. You might review their operation in earlier chapters (sections 3.C and 10.A). Some additional notes are pertinent here.

12.E.1 Beacons: KaNodes have a fairly distinctive beacon.

```
N7CPA>ID
N7CPA/R NBG/D N7CPA-1/B N7CPA-3/G N7CPA-7/N

N7KMM>ID
N7KMM/R JOE/D N7KMM-1/B N7KMM-3/G SPRING/N
```

The format for these beacons is as follows: the identifier followed by /N is the node name. It can be either an alias or a callsign. This is what you connect to for connection services.

The identifier followed by /B is the BBS (mailbox). This is what you connect to to leave or get mail. SSID of 1 is commonly used.

The identifier followed by /D is the digipeater. This is what you use to digipeat. In general, other SSIDs of this call will not digipeat!

The identifier followed by /R is the basic identification of the node. This is usually the callsign without any SSID.

The identifier followed by /G is the gateway. Using this callsign permits one to digipeat from one side of the KaNode to the other. For example, suppose that you are on HF and happen to be on the same frequency as W9AA-3/G. Also, suppose that N9ZZ is accessible on the VHF side of the W9AA KaNode. You can use the following connect command: *C N9ZZ v W9AA-3* . W3AA-3 will hear this connect request and serve as a digipeater, digipeating from (in this case) the HF side to the VHF side. If the VHF path is good, N9ZZ will hear this digipeated connect request and respond. The same process works from the VHF side to the HF side.

12.E.2 Node Connects vs Digipeating: The comments concerning node connection vs digipeating in sections 3.C and 3.D apply equally in HF. There are though, as one might expect, some special considerations.

Digipeating is undeniably faster when it comes to establishing a link.

You simply type out the connect string with all the digipeaters and, if it all works, back comes the acknowledgement. When you use node connection services, you get back the logon message from each one, then tell it the next connection, and so on. So, if speed of setting up the link is a major issue, digipeating will win out.

But if you expect to carry on an extended conversation, using node connection services is superior. The number of packets cluttering the frequency are reduced because retries are handled between the two points where the failure actually occurred. Using digis requires each error correcting retry to be resent from one end all the way to the other. Using the connection services of KaNodes does not add the networking overhead characters used by Net/Rom nodes so the penalty is very small. On top of this, the stay-connected feature of a KaNode can really help; this is discussed in the next section.

12.E.3 Stay Connected: KaNodes have a very interesting feature known as stay-connected. If you ask a KaNode to connect you to something else (either on the same frequency or on the cross-frequency) and the link fails, that resulting disconnect ripples back to the KaNode and it, in turn sends a disconnect on to you. This is the way a "normal" (that is, not stay-connected) connect works.

But if you tell the KaNode to connect you to something else and to stay connected, the disconnect from the far side of the KaNode stops right there. The KaNode notifies you with a special message. The following example shows the result of a stay-connected connect between the node ALBOR (origin) and the node MOORE. The link was setup and operated, then failed.

```
###DISCONNECTED BY MOORE AT NODE ALBOR
ENTER COMMAND: B,C,J,N,X, or Help ?
```

This message shows that a disconnect (for any reason) happened beyond ALBOR. The result rippled back to that point but stopped.

This connection was established from the VHF side of ALBOR by using the command *X MOORE S*. The *X*, as discussed earlier is the cross-connect command. This is followed by the name or callsign of the station being connected to. What is different is the ending *S*. This last character indicates that the connection is to be made as a stay-connected type.

12.F SUMMARY

Operation on the HF amateur bands requires some equipment which is slightly different than that used on VHF. Radio baud rates are different as are tone frequencies. Beyond this difference and the requirement for a stable and easily tuned HF transceiver, the equipment needs differ little from VHF.

Operating frequencies are limited and the propagation has all of the vagaries of other HF modes. There are a number of operating strategies which are unique on HF. Likewise, the extensive use of KaNodes serves to add to the differences between VHF and HF.

Chapter 13 PACKET SATELLITES

Maybe the idea of using satellites for packet contacts tickles your fancy. This chapter will attempt to provide some information to help you decide whether you really want to or not.

The author is even less of a packet satellite expert than he is an expert on H.F. He has operated a few times using a digipeater on the MIR space station. That can be really exciting but it represents a very small part of satellite use.

13.A WHAT'S UP?

There are several broad categories of satellites which support packet operation. Here, we will look at these groups of satellites.

13.A.1 Manned Space Stations: The Soviet MIR space station and the U.S. Space Shuttle program have both, at various times, included packet operation. The usual style seems to have been operation in space just like on the surface. Standard AX.25 TNCs with VHF transceivers having a few watts output seem to have been the rule. Two meters seem to have been the most popular band. MIR has frequently used 145.55MHz. Since ordinary TNCs are normally used, they seem frequently set up so that you may connect to a mailbox or use it as a digipeater.

The inclusion of packet on a particular mission seems to depend on whether there are hams among the crew and whether the radio equipment is compatible with the rest of the mission.

On can usually find out about these events by watching BBS bulletin lists. In the case of shuttle flights, bulletins often start showing about a week before launch. U.S. Space Shuttle flights with ham radio are referred to as SAREX (Shuttle Amateur Radio EXperiment) and bulletins usually include the word SAREX in the subject. Shuttle flights seem to frequently be in low inclination orbits; do not expect access much above 45° (N or S) latitude. The MIR orbit is at a higher inclination and is

accessible from above 50° (N or S).

Using one of these stations is little different than connecting to your neighbor at home. One very big difference is the coverage area; virtually every other user is hidden to every one else. Also, these events are relatively rare and the user load can be huge.

13.A.2 Geostationary Satellites: Though planned, there are no geostationary ham satellites in space at the time this is being written.

13.A.3 High Orbit Satellites: AMSAT-OSCAR 13 (AO-13) is a satellite in a highly elliptical orbit. This orbit is such that it swings well away from the earth; it is frequently referred to as Phase III orbit. It is visible for an extended period and is relatively slow moving when away from the earth. There are does not appear to be any dedicated packet operation although packet seems to be permitted as a mix with other modes. Because of the rather large satellite-to-earth distances, transmit power and receiver noise figure are major issues. There is a baudot telemetry beacon; the author assumes this mean RTTY.

AO-13 has 4 different modes. Each one represents a particular input-output frequency combination. For example, mode B is uplink on 70cm and downlink on 2M; mode J is uplink on 2M and downlink on 70cm. There are also a pair of modes which translate between 70cm and 2.4GHz. The mode schedule is often broadcast by BBS bulletins. Remember, however, that this satellite, as for most others, uses CW or SSB, not FM!

A new satellite launched in mid-1993 is **ARSENE**. This on is also in a highly elliptical obit going from 36,000km at the maximum (apogee) to 20,000km at the minimum (perigee). Orbital period is about 17hours and 30 minutes. It is expected to have a life of about 3 years. It is not obvious to the author whether it has been given has been given an OSCAR designation.

The expected packet 70cm uplink/2M down link is not operating. There is, however, a 435.100MHz uplink/2400MHz downlink. Transmit requires 500-1000W EIRP (50W into a 10db gain antenna) works. The downlink is some 10db weaker than AO-13, however and the antenna requirement is equivalent to a 6' dish.

13.A.4 Microsats: These six satellites were launched in January, 1990.

The orbits of all four at very similar and all are visible about 15 minutes at a time, 4 to 5 times per day (at mid-latitudes). Their altitude is low. They are simple. Because of their small size and weight, they can be launched at lower cost. The group consists of University of Surrey (England) UoSAT-3 (UO-14) and UoSAT-4 (UO-15), AMSAT AO-16, OSCAR-17, Weber OSCAR-18 (WO-18), and AMSAT LO-19. Lets consider each of these six satellites in numerical order.

UO-14 has one uplink and one downlink, both at 9600 baud. Uplink and downlink are full duplex (on different bands).

The author has no information about **UO-15**; it does not appear to support any special packet operations.

AO-16 is also known as PACSAT. AO-16 has 4 uplinks and 1 downlink running at 1200 or 4800 baud (switchable). A PACSAT modem is required for operation. Uplink is on 145.900, 145.920, 145.940, and 145.960 MHz while the downlink is on 437.025, 437.050, or 2401.143 (full-duplex).

This satellite is basically a flying mailbox. But operation style is very different from earth-bound ones. They forward bulletins by broadcasting to everyone listening. Every bulletin is sent over and over until all of the pieces are received and patched together by everyone interested. It may take several passes for one to be received in its entirety. The ground station must be able to reassemble the individual pieces into a complete message. The satellite continues broadcasting until there are no more requests for repeats or the message is too old and must be purged. Personal messages are handled on a direct connect basis. So is placing a message (personal or bulletin) into the mailbox.

It usually requires moderate-gain directional antennas with full tracking capability. It also requires special software to format messages to meet the satellite requirements and to compress the messages (reducing both connect time and satellite memory needs). The special software is also needed to reassemble broadcast bulletins. When one adds the dual-band radio needed, this is not an inexpensive undertaking!

AO-17 is also known as DOVE (Digital VOice Encoder). Its primary mission is to broadcast digitized audio messages on FM for classroom use. It has a packet telemetry channel which can be decoded by G3ZCZ's WHATS-UP. Telemetry frames are 1200 baud UI frames (in pairs) addressed to DOVE-1>TLM. The downlink appears to be on

145.825MHz.

WO-18 (WEBERSAT) carries a camera. The images are digitized and transmitted on a packet downlink operating on 437.102. A 1200 baud PACSAT modem is required for reception.

LO-19 (LUSAT) is almost identical to AO-16.

13.A.5 Sun Synchronous Satellites: Fuji-Oscar 20 was launched in February, 1990. It is in a sun synchronous orbit which means that it crosses a given longitude at approximately the same time, morning and evening, every day. The Japanese designation is Fuji-2 and the international designation is FO-20 (Fuji-OSCAR 20). The orbital period is about 105 minutes and the expected service time is 5 years.

This satellite is designed for packet operation. It has 4 uplink channels (145.85, 145.87, 145.89, 145.91 MHz) and 1 downlink channel (435.91 MHz). Packet operation requires the same PSK modem as needed for PACSAT. Uplink requires about 100W EIRP. The packet callsign is 8J1JBS.

There are several interesting features for packeteers on this satellite. One is the digipeater. It will digipeat any valid packet heard; you do not have to specify the satellite as a "via" in the connect request. The digipeat is cross-band (that is, the outgoing packet is on the downlink). Another interesting feature is the bulletin board; it carries a large computer memory for message storage. The BBS is accessible with common mailbox-style commands.

The downlink contains telemetry frames which are broadcast as UI packets. They are addressed 8J1JBS>BEACON. If you have a PACSAT modem, you can copy and translate the telemetry with G3ZCZ's WHATS-UP program (see Chapter 19 in Volume 2).

There is a caution about FO-20. It does not automatically disconnect you when the signal is lost. This means that when it goes over the horizon, it considers that you are still connected. The problem is that it permits only 16 simultaneous connects. If it goes over the horizon with you still connected, your lost connection stays on as 1 of the 16. So, please disconnect before signal is lost!

13.A.6 Other Satellites: KITSAT-1, also known as KO-23 was launched early in 1993. This satellite is a Korean effort including 9600 baud packet, earth imaging, cosmic ray experiments, and digital signal processing experiments.

Unlike other packet satellites, this one uses FM on both the up and down links. There are two uplink frequencies (145.850 and 145.900MHz) and a downlink on 435.175MHz. Transmit requires 25-100W EIRP and receive needs a GaAsFET preamp and a small beam. PSK is used as with the PACSATS but at 9600 baud. The packet callsign appears to be HL01-11 (thats zero-one dash eleven). It uses the broadcast protocol very similar to FO-20.

UoSAT-OSCAR 22 (UO-22) is also a packet satellite. It operates at 9600 baud. Beyond this detail, the author has little information.

OSCAR-21 (AO-21) has packet telemetry and voice. It has a downlink on 145.987MHz FM (145.990 works fine) and an uplink on 435.016MHz FM. It is in a fairly low orbit and has viewing times in the neighborhood of 15-20 minutes.

13.B FINDING SATELLITES

After questions of equipment and frequencies, the next most often asked question often seems to be "how can I tell when a satellite is coming over?" You can use one of several tracking programs for computers or you can do some simple estimating. But in either case, you need to start with some basic information about the orbit of the satellite. The standard set of information is called the Keplerian Elements.

13.B.1 Getting Keplerian Elements: Keplerain Elements are available on a regular basis from several sources. A number of telephone bulletin boards around the U.S. have them available in a timely manner. They are also available in Internet. They are also distributed through the radio BBS system in many areas.

13.B.2 Keplerian Element Formats: Once you have a recent set of the elements, the next issue is what they mean. Here, we have a minor problem. They have been issued in two formats, AMSAT and NASA. In 1991, AMSAT format was generally dropped in favor of the NASA format. But many of the older tracking programs expect data files in

AMSAT form. The following conversion information was apparently written by Dr T.S. Kelso, Assistant Professor of Space Operations, Air Force Institute of Technology and was taken from an Internet message dated August 31, 1990.

Data for each satellite consists of three lines in the following format:

```
AAAAAAAAAAA
1 NNNNNU NNNNNAAA NNNNN.NNNNNNNN +.NNNNNNNN +NNNNN-N +NNNNN-N N NNNNN
2 NNNNN NNN.NNNN NNN.NNNN NNNNNNN NNN.NNNN NNN.NNNN NN.NNNNNNNNNNNNN
```

Line 1 is a eleven-character name.

Lines 2 and 3 are the standard Two-Line Orbital Element Set Format identical to that used by NASA and NORAD. The format description is:

Line 2

Column	Description
01-01	Line Number of Element Data
03-07	Satellite Number
10-11	International Designator (Last two digits of launch year)
12-14	International Designator (Launch number of the year)
15-17	International Designator (Piece of launch)
19-20	Epoch Year (Last two digits of year)
21-32	Epoch (Julian Day and fractional portion of the day)
34-43	First Time Derivative of the Mean Motion or Ballistic Coefficient (Depending on ephemeris type)
45-52	Second Time Derivative of Mean Motion (decimal point] assumed; blank if N/A)
54-61	BSTAR drag term if GP4 general perturbation theory was used. Otherwise, radiation pressure coefficient. (Decimal point assumed)
63-63	Ephemeris type
65-68	Element number
69-69	Check Sum (Modulo 10) (Letters, blanks, periods = 0; minus sign = 1; plus sign =2)

Line 3

Column	Description
01-01	Line Number of Element Data
03-07	Satellite Number
09-16	Inclination [Degrees]
18-25	Right Ascension of the Ascending Node [Degrees]
27-33	Eccentricity (decimal point assumed)
35-42	Argument of Perigee [Degrees]
44-51	Mean Anomaly [Degrees]
53-63	Mean Motion [Revs per day]
64-68	Revolution number at epoch [Revs]
69-69	Check Sum (Modulo 10)

All other columns are blank or fixed.

Example:

```
NOAA 6
1 11416U          86 50.28438588 0.00000140           67960-4 0  5293
2 11416  98.5105  69.3305 0012788  63.2828 296.9658 14.24899292346978
```

Note that the International Designator fields are usually blank, as issued in the NASA Prediction Bulletins.

Additional conversion information was provided by Mike Bilow, N1BEE@ KA1RCI.RI.USA.NA in a BBS bulletin dated February 16, 1992.

```
Note that some software will not correctly read all of the (NASA)
fields, often stumbling over the assumed decimal point in the
eccentricity field.

Also, decay rate or drag is usually given in AMSAT format in
scientific notation, which is not used in NASA format.  To convert,
simply move the decimal point to the left as many places as are
indicated in the negative exponent.  For example, 1.234e-05 becomes
0.00001234, and 6.789e-03 becomes 0.006789; most software will take
this number entered either way.

All epochs are UTC (Coordinated Universal Time).

Example:

STS-35
1 20980U 90106  A 90340.71451300  .00053642  00000-0  37954-3 0   129
2 20980  28.4668 332.8436 0011228 341.6274  18.4530 15.72433683   705

AMSAT Format:
Satellite: STS-35
Catalog number: 20980
Epoch time:      90340.71451300
Element set:      12
Inclination:       28.4668 deg
RA of node:       332.8436 deg
Eccentricity:    0.0011228
Arg of perigee:   341.6274 deg
Mean anomaly:      18.4530 deg
Mean motion:   15.72433683 rev/day
Decay rate:     5.3642e-04 rev/day^2
Epoch rev:              70
```

13.B.3 Using Keplerian Elements: It is possible to make some fairly simple estimates of satellite passes without extraordinary mathematical gymnastics. All that it requires is some simplifying assumptions. The

assumptions I have made are: (1) the orbit is circular (which leaves out the Phase III satellites) and (2) many of the more subtle orbital mechanics issues can be ignored for a while after the epoch time.

The method I have chosen is to determine where a crossing of the equator must happen in order that a pass be visible. Then, an estimate of equator crossing times and locations is made. By cross-checking these values, you can determine pass times. You will need to know your latitude and longitude to about 1 degree or so. This method will not provide any antenna pointing information.

Step A: Based on orbit altitude, determine how large an area over which the satellite can be seen. The radius of the circle (on the earth's surface) in which a satellite is visible is given by

$$r = R * k * \text{atn}\left[\frac{h}{R}\sqrt{1 + 2\frac{R}{h}}\right]$$

where R is the radius of the earth (6378km) and h is the orbital altitude of the satellite (in the same units as R). The factor k is used according to whether your calculator gives angles in degrees or radians from the atn (arctangent) function. If your calculator gives the answer 45 to the function atn(1), then use k=pi/180 (to convert degrees into radians). But if your calculator gives the answer 0.785, use k=1 since the answer is already in radians.

There is, however, a minor hitch. Orbital altitude is not given in the Keplerian Elements. Orbital period is. And altitude is directly related to period by

$$T^2 = \frac{4\pi^2}{G * M} r^3$$

where T is the orbital period, M is the mass of the earth, and G is the Universal Gravitational Constant, and r is the radius of the satellite's (circular) orbit.. When we are interested in a satellite orbiting the earth, this equation reduces to

$$r = 33125 * T^{2/3}$$

if T is in minutes and r is in kilometers. The orbital altitude of the satellite is

$$h = r - R$$

$$h = 33125 * T^{2/3} - 6378$$

The Figure 13-1 gives radius of satellite viewing circle and the orbital radius (both in km) as determined by orbital period.

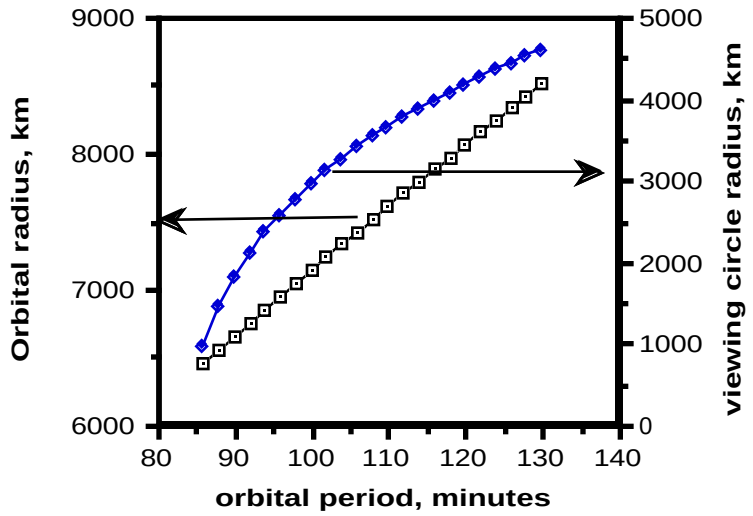

Figure 13-1, View-Circle Radius and Orbit Radius for various Orbit Periods

The final consideration is that the Keplerian Elements do not give orbital period directly. Instead, it gives "mean motion" which is the number of orbital revolutions in one day. To find the orbital period, simply divide this value into 24*60=1440, the number of minutes per day. In the example from section 13.B.2, the orbital period is therefore 91.578 minutes or 91 minutes, 34.68 seconds.

Step B: The second step is to determine how many degrees of latitude and longitude the radius of the viewing circle occupies at your site. Lines of longitude go from pole to pole and all have the same circumference; lines of latitude are parallel to the equator and ones nearer the poles have a smaller circumference. Both longitude and latitude are divided into 360 degrees. What may be confusing to some, however, is the actual measurement of latitude and longitude. Longitude (in degrees) is a measure of how many lines of longitude one has crossed east or west of Greenwich Meridian (that is, while travelling along a line of latitude!) Similarly, latitude (in degrees) is a measure of how many lines of latitude one has crossed north or south of the equator (that is, while travelling along a line of longitude!)

To find the east-west radius, slice the earth at your latitude (circles

parallel to the equator). The resulting circle has a circumference which is determined by the radius of the earth and the latitude where the slice takes place. From this, we can determine the distance occupied by one degree of longitude; there are 360 degrees of longitude around this circle which has a radius of R*COS(LAT). Combining this value with the radius of the viewing circle from Step A results in an estimate of the east-west width of the viewing circle in degrees. The north-south radius is the same everywhere on the earth and is found much the same way, except the slice is along a line of longitude.

The number of km in one degree of longitude (lets call it Q_{LON}) at a latitude of LAT is given by

$$Q_{LON} = 2*\pi*R*COS(LAT)/360$$

where R is the radius of the earth. If we combine the constants in this equation, the result is

$$Q_{LON} = 112km*COS(LAT)$$

The number of km in one degree of latitude (lets call it Q_{LAT}) is simply 112.2km.

The next figure, Figure 13-2, shows the value of Q_{LON} (number of kilometers in 1 degree of longitude) for degrees of longitude from 0 (equator) to 50. It makes no difference, here, whether you are north or south of the equator.

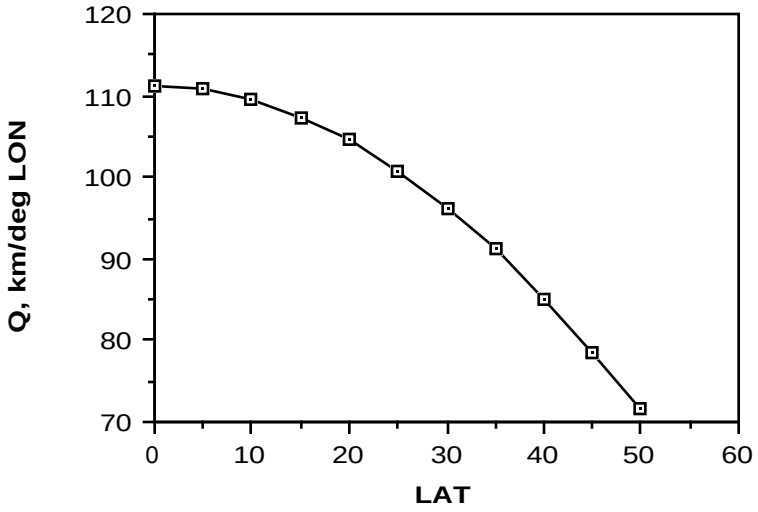

Figure 13-2 Q_{LON} vs Latitude

The last part of this step, which is not convenient to graph, is to divide radius of the viewing circle by Q_{LON}. This gives the east-west radius of the viewing circle, in degrees of longitude. Similarly, divide the radius of the viewing circle by Q_{LAT} to find the north-south radius of the viewing circle in degrees of latitude.

For example, if the satellite in question has an orbital period of 91.578 minutes (in other words, the example satellite), the radius of its viewing circle is about 2200km. If you are at 40 degrees south latitude, your value of Q_{LON} is about 78 km/degree. Thus, the east-west radius of the viewing circle occupies about 28 degrees of longitude; the east-west diameter is twice this, or about 56 degrees of longitude. The north-south radius is about 20 degrees of latitude.

Step C: The next step is to estimate when the satellite crosses the equator. This estimate involves several quantities from the Keplerian Elements.

The first part of this step is to understand what Epoch time means. Epoch time is a decimal time and date value. The example in section 13.B.2 shows an Epoch time of 90340.71451300. The first 3 digits to the left of the decimal point are the Julian day. January 1 is day 001, February 1 is day 032, December 31 is day 365 (or 366 if a leap year). In this example, the day is 340. The next digits to the left of the day number are the least two digits of the year. In the example, these digits

are 90 so the day is day 340 of 1990. The digits to the right of the decimal point give time as a decimal part of one day, that is 24 hours. Though it is not necessary for our purposes to convert to hours, minutes, and seconds, we can readily do so. Hours are found by multiplying 24 hours by the decimal part of Epoch time. In the example, the hour part is 24*0.71451300 or 17.148; hours are the integer part, or 17. The portion to the right of this number is decimal part of hours. Multiplying this fraction by 60 (minutes per hour) gives minutes. In the example, the minute part is thus 60*0.148 or 8.88. Minutes could be rounded to 9 or further reduced to seconds. Seconds are obtained by multiplying the fractional part by 60 (seconds per minute). In the example, the seconds part is thus 60*0.88 or 53. Thus, the complete time represented by the Epoch time in the example is 17:08:53 on day 340 of 1990. It is the convention that Epoch time is given in GMT.

The satellite makes each subsequent north-bound crossing of the equator one orbital period time after the preceding crossing. Furthermore, each south-bound crossing of the equator happens one-half of an orbital period after the north-bound crossing. For the satellite in the example, the next north-bound equator crossing is at 91.578 minutes after the Epoch time (17:08:53 GMT) or 18:40:27 GMT. Note that while any individual time need be accurate only to a few seconds, you should maintain several digits to the right of the seconds decimal point since errors will accumulate fairly rapidly. The next north-bound crossing will be at 20:22:02 GMT.

Step D: Knowing when the satellite crosses the equator must be combined with where the satellite crosses the equator. This involves the RA of node data from the Keplerian Elements.

The RA of node has nothing to do with packet nodes. It gives the location, called Right Ascension (in degrees longitude) where the satellite crosses the equator north-bound at the specified Epoch time. An oddity of this value is that given in a range of 0 to 359.9999 degrees positive eastward of Greenwich Meridian. In the example, the RA of the example is 332.8436 degrees. Any value between 0 and 180 may be taken directly as East Longitude. Values greater than 180 may be converted to West Longitude by subtracting from 360. The example thus crosses the equator at 27.156 degrees West Longitude. And it makes this crossing at the Epoch Time which was analyzed in the preceding step.

But what about the subsequent equatorial crossings? Here, it gets a bit complex and several simplifications will be used. There are two components which interact to determine equatorial crossings. One is the rotation of the earth and other is the rotation of the plane of the satellite's orbit in space. It is quite possible to get wrapped up in distinctions between Siderial time and Sun time but for intervals of a few days or less, the error from using Sun time (that is, clock time), is reasonably small. Using this simplification, we will find the number of degrees which the earth rotates during one orbital period. The earth rotates 360 degrees in 24 hours clock time or 15 degrees per hour. It may be simpler to use degrees per minute since orbital period is usually expressed in minutes. Earth rotation in degrees per minute is the degrees per hour value divided by 60 minutes per hour. Thus, earth rotation is also 0.25 degrees per minute. In our example which has an orbital period of 91.578 minutes, the earth rotates 22.895 degrees during each orbit and 11.449 degrees between every equator crossing.

That, however, is not the whole picture. We need to make certain we understand which way the earth rotates. You can visualize what happens by looking at a globe which turns. If you start looking when the Greenwich Meridian is directly below, the numbers along the equator increase in a westerly direction. When you reach the area of International Date Line, the numbers switch to East Longitude and decrease from 180 toward 0. The convention in earth satellite orbital mechanics is eastward positive; thus, the earth's rotation is -0.25 degrees per minute. Then, for our example, the earth rotates -22.895 degrees during each orbit.

One last factor must be considered before the whole series of equatorial crossings can be estimated. This factor is the rotation of the plane of the satellite's orbit in space. If we were to sit in space directly above one of the earth's poles, further out in space than the orbit of the satellite and ignore the rotation of the earth, we would also see that the plane of the satellite's orbit slowly rotates below us. This orbital-plane rotation is called precession and is controlled by the inclination of the orbit. Precession is an effect which is due to the fact that the earth is not a perfect sphere; it bulges at the equator. Inclination is the angle between the equator and the plane of the orbit. The rate of orbital-plane rotation for an earth satellite is given by

$$d\Omega/dt = 9.95\left(\frac{R}{r}\right)^{3.5}\cos(i)$$

This is an empirical equation. The quantity $d\Omega/dt$ is in degrees per day. A positive value indicates clockwise rotation of the orbital plane as seen from above the north pole. In our example, the inclination angle, i, is 28.4668 deg. Given the values of R (earth's radius = 6378km) and r (satellite's orbital radius = 7300km from the figure in Step A), the precession rate is 5.2 degrees per day. Note that a true polar orbit, in which i=90 degrees, (that is, the satellite crosses the equator heading exactly due north) has a precession rate of zero. Also, a satellite with a an inclination greater than 90 degrees has a negative precession and the orbital plane rotates counter-clockwise as seen from above the north pole. An inclination of 45 degrees means that the satellite heads northeast as it crosses the equator north-bound; an inclination of 135 degrees means that the satellite heads northwest as it crosses the equator north-bound.

We really need to know the rotation of the orbital plane during one orbit. Lets call the change in the angle of the orbital plane during one orbit, $\Delta\Omega$. If T is the orbital period, in minutes, then

$$\Delta\Omega = \frac{d\Omega}{dt} * \frac{1}{24} * \frac{1}{60} * T = \frac{d\Omega}{dt} * \frac{T}{1440}$$

Is the rotation of the orbital plane added to or subtracted from the earth's rotation? If the two are rotating in opposite directions, then the change between successive right ascensions is even greater. Thus, since earth rotation counter-clockwise as seen from above the North Pole, $\Delta\Omega$ is subtracted from earth's rotation. For our example satellite, $\Delta\Omega$ is 0.331 degrees per orbit and the total change in RA is -22.895-.331=-23.226 degrees (that is, 23.226 degrees westward). This change is called the orbital increment.

The next RA after the Epoch Time thus happens at the RA given in the Keplerian Elements shifted west 23.226 degrees or 27.156+23.226=50.382 degrees. Each subsequent RA is another 23.226 degrees west of the preceding one.

Step E: The final step shows which orbits are visible and when they occur. Make 2 copies of the Figure 13-3, the ORBITRACK chart, on page 13-16.

On one copy, locate the site of your station. If you are in the southern hemisphere, swap east and west on the equator. Mark out the east-west and north-south extents of the circle of visibility centered at your site.

Connect these four points with a smooth line which might be somewhat egg-shaped. This line is the edge of the circle of visibility. A satellite crossing anywhere within this circle is visible from your site. With a sharp knife, cut along the visibility circle to make a hole. Note the arrowhead mark on the 0° longitude (Greenwich Meridian). Then, trim off the outer part of this copy along the circle where the arrowhead points (equator).

On the other copy, mark the orbit. For convenience, start with a mark at Greenwich Meridian (0 on the equator). If the orbital inclination is less than 90 degrees, find the point along the 90°E longitude line at a latitude equal to the inclination angle. If the inclination is greater than 90 degrees, find the point along the 90°W longitude line equal to (180-inclination). For our example satellite with an inclination of 28.4668 deg, mark on the 90°E longitude line about 28.5 degrees north of the equator (not very far north!). If the inclination had been 110 degrees, the mark would have been on the 90°W longitude line 70° north of the equator. Make a third mark on the equator near the 180° point. If the orbital increment is negative, place this mark clockwise of the 180° line a distance of one-half the orbital increment. If the orbital increment is positive, place the mark counter-clockwise of the 180° line a distance of one-half the orbital increment. For the example satellite which has an orbital increment of -23.226 degrees, make this mark about 12 degrees CW of the 180 mark (or 168°E). Make a smooth arc connecting these three points. Cross each latitude line only once between 0° long and 90° long and only once between 90° long and 180° long. Color the half between Greenwich Meridian and the 90° longitude line green and the other half red. Green indicates moving away from the equator and red, toward the equator. Extend these red and green lines out to the outer-most circle (which has no longitude lines).

Now, place a pin though the center mark of the first copy. Put this copy over the second copy (the one with the orbit marked) and pin them together so that they rotate relative to each other. Notice that as they are turned, there are positions where the orbit shows through the viewing-circle hole and other positions where the orbit is hidden. There may be two discontinuous settings of the top disk where the orbit is visible; this is usually the case only with orbits which have inclinations near 90° and when this happens, the point where the orbit changes from green to red cannot be seen inside the hole.

Rotate the two disks until the green orbit line just becomes visible in the hole. Make a green mark on the edge of the upper disk opposite the 0°

mark of the lower disk. Continue to rotate the disk. If the point where the orbit changes from green to red shows in the hole, continue to turn the disks until about equal lengths of red and green line show. Place a mark (red or green) on the edge of the upper disk opposite the 0° mark of the lower disk. If the green line disappears from the hole, place a green mark on the upper disk opposite the 0° mark of the lower disk at the point where the orbit just disappears. Do the same with red marks where the red portion of the orbit just appears and disappears. Color the top disk green between the green marks and red between the red marks.

Next, align the arrowhead mark of the upper disk with the 0° longitude line on the lower disk Write down the range of longitudes where the green coloring is and where the red coloring is (using the longitude scale along the equator of the lower disk since it was cut off of the top disk).

An RA anywhere within these longitude values produces a satellite pass which is visible from your site. If the RA is one in the green range, you will see the satellite moving from the equator toward the pole; if the RA is in the red range, it is moving from the pole toward the equator. You need only to use the orbital increment to estimate the sequence of RAs after the Epoch Time. Use the orbital period to determine when the RAs happen. Any RA which falls within either the green range or the red range should interest you.

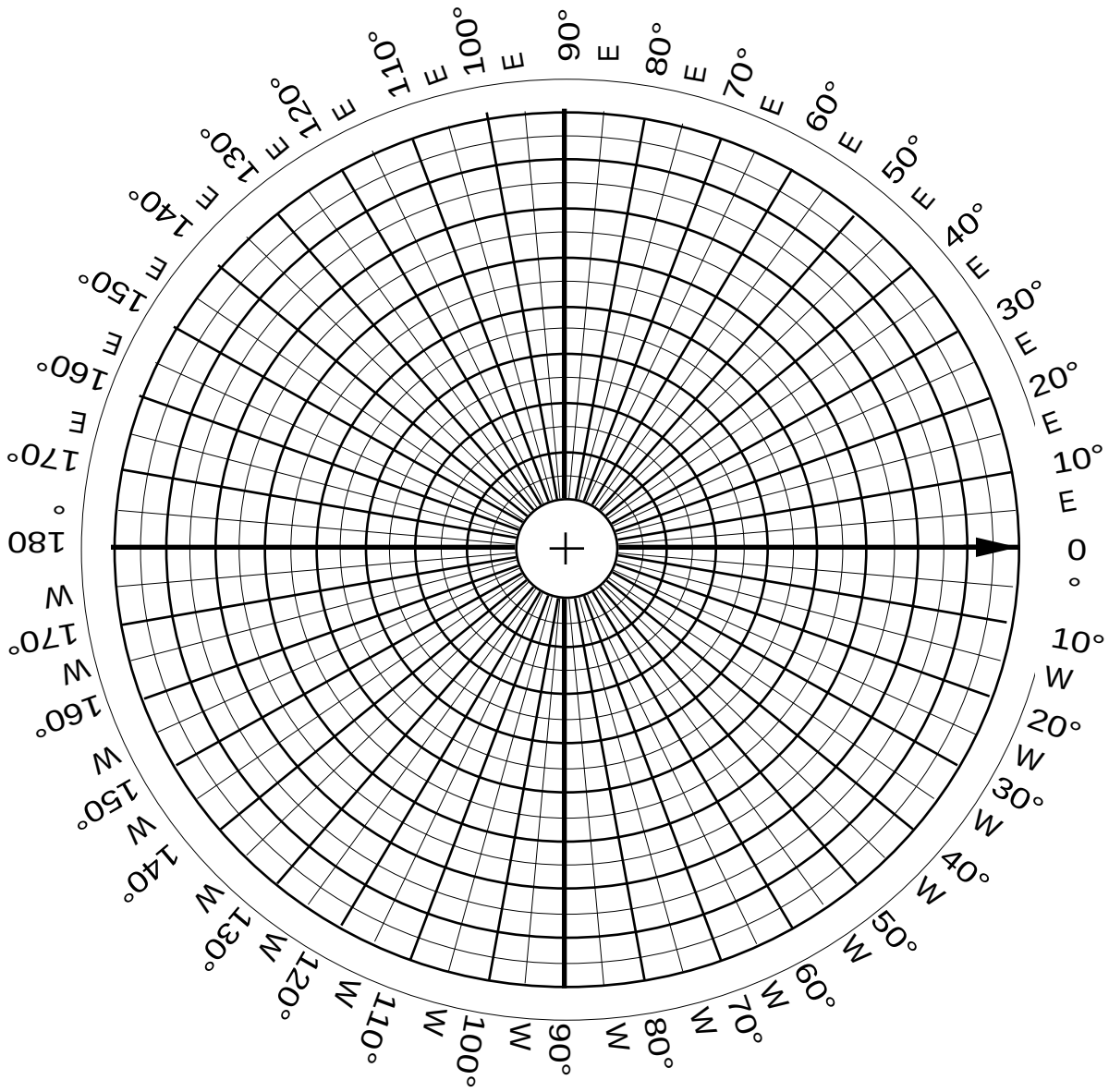

FIGURE 13-3, ORBITRACK CHART

A Worked-out Example: The author's location is about 122°W and 45° N. From Step B, Q_{LON} is about 80km per degree and Q_{LAT} is a 111.2km per degree. Since the viewing circle for the example satellite has a radius of 2200km, the east-west extent of the viewing circle is 27.5 degrees and the north-south extent is 19.8 degrees. Thus, the viewing circle at the author's location extends from [64.8°N, 122°W] to [45°N, 94.5°W] to [25.2N, 122°W] to [45°N, 149.5°W]. The oval which links these four points is cut out of the first copy as described. The second copy is marked with the orbit exactly as outlined in Step E.

The first thing which might be discovered is that the orbit barely shows above the lower edge of the viewing circle. This should tell us that the satellite, when it is visible, will always be low on the southern horizon. In fact, the orbit is so low that it is quite difficult to discern precisely when it is visible.

Rotate the two disks as described; mark the upper disk (opposite the 0° line of the lower disk) when the green orbit first appears in the viewing circle. Turn the upper disk further until equal amounts of green and red orbit show in the circle; put both a red and a green mark on the upper disk opposite the 0° line of the lower disk. Finally, continue turning until the red orbit just disappears from the circle and mark the upper disk with a red mark (again, opposite the 0° line of the lower disk). Now color with a red marker on the upper disk between the two red marks and with a green marker between the two green marks. To determine the corresponding RAs, rotate the upper disk until the arrowhead on the upper disk which denotes its 0° longitude lines up with the 0° latitude on the lower disk. We can now read off the range of RAs which result in visible satellite passes. It should come out green between 170°E and 148°E and red between 148°E and 120°E. Any RA in this range will result in a visible satellite. The following brief table shows a number of RAs after the Epoch Time. These are also marked with orbit number. Note from the original Keplerian Elements that the orbit for the given Epoch Time is orbit 70.

Orbit number	RA	Time, GMT
70	27.156°W	17:08:53
71	50.382°W	18:40:28
72	73.608°W	20:12:03
73	96.834°W	21:43:38
74	120.060°W	23:15:13
75	143.286°W	00:46:48
76	166.612°W	02:18:23
77	170.262°E	03:49:58
78	147.036°E	05:21:33

Orbit 77 might be visible for a very short time. Orbit 78 falls near the middle of the visible range. Note that the times shown are equatorial crossing. The satellite will become visible, when it does, a short time after the time shown.

Note, particularly, how the RA value is handled after the crossing of the International Date Line at 180°.

13.C MORE INFORMATION

This chapter has been very sketchy. There are several books which can provide more information. These are listed in the Bibliography (Volume 2). Your national amateur satellite organization can also provide a lot of information. In the United States, contact AMSAT-NA at 850 Sligo Ave, Silver Spring, MD, 20910-4704. Include a self-addressed and stamped envelope when requesting information.

Software and Keplerian Elements are available on a number of telephone bulletin boards. These include the AMSAT BBS (201) 261-2780, the SPACELINK BBS (205) 895-0028, the Dallas Remote Imaging BBS (214) 394-7438, and CompuServe.

Chapter 14 FILE TRANSFER

File transfer concerns the exchange of computer "files" with other packet stations.

14.A TEXT FILE TRANSFER

A text file is one which contains ASCII characters representing text. Only a few specific control characters are included. These are usually such things as carriage returns.

Virtually every computer includes this basic file type. On MS-DOS machines, when you do a *`TYPE filename.ext`* and get out a screen listing as it was typed, it is a text file. C64, Macintosh, and all others of which the author is aware have similar file types. This does not mean that they can be read by exchanging disks. But they can be exchanged by packet. This is because, to the computer, the packet input and output is as if it were typed on that machine.

14.A.1 SENDING TEXT FILES: Almost every terminal program has a "SEND TEXT" option. It may masquerade by different names. Sometimes it appears as "UPLOAD". In general, you simply specify the file name (including extensions for non-Macintosh users).

The computer then sends the text out the serial port to your TNC as if you were typing it. Depending on the program, it may not always end by itself. You may need to specify when the end has occurred.

The only "trick" is that the station at the other end usually must be prepared before the sending starts. See the next section.

14.B.2 RECEIVING TEXT FILES: Almost every terminal program has a "RECEIVE TEXT" option. It may masquerade by different names. Sometimes it appears as "DOWNLOAD" or "CAPTURE". In general, you simply specify the file name (including extensions for non-Macintosh users).

In general, you must initiate CAPTURE prior to the arrival of the first text. Computers which support mouse text selection (such as Macintosh or Windows) may permit you to choose the text on the computer screen after it has been received, then copy it, and paste it into another program (such as a text editor). It can then be edited, if appropriate, then saved.

14.A.3 WHY USE TEXT FILES?: Your BBS messages will look a lot better if you prepare them before-hand with a text editor. Then, when it is all "spiffed up", you can send it. It goes a lot faster, also, than when you type it directly.

14.A.4 CREATING TEXT FILES: Most editors ("word processors, by another name) will produce text files. Simply type the message and save it as a "plain text" file. For example, "BRIEF" (a text editor widely used by programmers) inherently produces plain text. "Word Perfect" allows you to save and input text files using the "TEXT IN/OUT" (control-F5). Microsoft "Word For Windows" does it if you use a file extension of *.TXT*. "PC-Write", one of the popular share-ware editors, does it directly. It appears that many of the Macintosh editors give you the "text" option from the "Save As..." item in the File Menu.

How do you tell if it is a plain text file? The easiest way on a "DOS" machine is to "TYPE" the file (from DOS, *TYPE filename.ext*). If it appears on the screen without strange characters (happy-faces and such), then you have done it.

Please, do not rely on line-wrap by the editor. Many editors in text mode leave out carriage returns at the wrap points. If the person receiving such a file has one of the several editors which cannot easily handle strings of characters longer than 256 without carriage returns, its a mess!

14.A.5 BBS MESSAGES: You can greatly simplify operation with a BBS if you include BBS control messages within your text. Consider the following simple message:

```
S KA7AGH @ KA7AGH.OR.USE.NA
NODES
Hi Jim -
How is progress going on the new node?
73 de Jim
/EX
b
```

A message of this type is sent from the basic BBS prompt. The first line is the "addressed send command" to the BBS. It returns with a request for the "subject" which is satisfied by the second line. Once the subject line is satisfied, it accepts message text; lines 3, 4, & 5 are recognized as message. The "*/EX*" terminates the message and the "*b*" disconnects you from the BBS! All you have to do in this scheme is connect to the BBS!

14.B NON-TEXT FILES

Non-text files are all those other computer files. They may be programs. They may be graphic files ranging from bit-map "paint" to "AutoCAD" or other technical files. In addition, Macintosh files have attached to them a "resource fork" which contains the "icon" for the file as well as information about the kind of program which created the file. In these cases, the file contains many non-text characters. As usual, there are several ways to deal with this situation.

14.B.1 CONVERSION TO TEXT: There are programs which will convert a non-text file into a text-only form. For the Macintosh, "BINHEX" encoding within "Stuffit" is one. A procedure named "UUENCODE" and "UUDECODE" does this for DOS files.

One of the problems with conversion to text is that the file size gets bigger (by about 2X). This is usually dealt with by compressing the original file. For most Macintosh files, "Stuffit" reduces files to about 50% of their original size. For DOS machines, the share-ware program "PKZIP" is a popular compression choice. Both Stuffit and PKZIP permit you to bundle together several files into a single "batch".

Once a text-version of the file has been created, it can be sent as described in section 14.A. The person receiving the file must have access to the proper decoding program. Stuffit both encodes and decodes BINHEX. Likewise the appropriate uncompression is required if this was done in the first place.

It should be pointed out that after conversion to text form, any computer can handle the file. This does not, however, give PCs the ability to use Macintosh files!

14.B.2 TRANSPARENT TRANSFERS: One of the problems with file transfers is the interpretation of file characters by the TNC. For example, if the the file happens to have a character which is the same as "control-C", the TNC immediately switches out of CONVERSE mode into COMMAND mode. At this point, everything grinds to a halt. TRANSPARENT mode was designed specifically for this circumstance. When in this mode, all characters are ignored by the TNC except for a very special set of characters which is not likely to be encountered in a file. You may, in fact, have to use TRANSPARENT mode with some of the protocols describe in the following section.

For TNC2 clones, this mode is entered from the COMMAND mode by typing `cmd: TRANS`. From this point on, the normal "control-C" has no effect! There are no "send packet" characters like the carriage-return in CONVERSE mode. Instead, a packet is sent when there are a certain number of characters accumulated in the TNC or when a certain time has passed. The number of characters is set in TNC2s with PACLEN; the time interval is set in TNC2s with PACTIME. The TNC does not echo these characters to the terminal screen as it normally does in other modes.

No matter how the TNC is set, it sends and receives full 8-bit characters. You should have the terminal program set to operate with 8 bits and NO parity.

TRANSPARENT mode can be exited in TNC2s in several ways. Some terminal programs allow the sending of a "break character". In actuality, this is not a true character and is not in the ASCII table. Sending this condition usually requires a menu selection in the terminal program.

The second exit from TRANSPARENT mode in TNC2s is governed by a parameter called CMDTIME. After the last character is sent, you must wait a time equal to CMDTIME. Then, during a the time CMDTIME to 2*CMDTIME, send the command character 3 times. Then, during the interval from 2*CMDTIME to 3*CMDTIME from the last character, there can be no keyboard entries. If you have been successful, you will see the command prompt! I find it useful to use a value for CMDTIME which is not too short (so that it is missed) or too long (which is frustrating). For me, 5 seconds has worked. Thus, I wait at least 5 seconds after the last file character, then within the NEXT 5 seconds, type 3 control-Cs, then wait another 5 seconds for the prompt.

14.B.3 FILE TRANSFER PROTOCOLS: Most terminal programs which were originally written for use with telephone modems support a variety of "modem" protocols. These include XMODEM, YMODEM, ZMODEM, and KERMIT. We should not forget, here, FTP used by TCP/IP stations. The same protocol must be used by both stations involved.

Among packet users, a number of programs have available a protocol called "YAPP" (Yet Another Packet Protocol). Another is PZC binary exchange protocol supported by LanLink software.

The author has not had much experience with these protocols, yet. It is quite obvious, however, that it may take some experimenting to make them work through TNCs. In part, this is due to the delays between send and acknowledge which is not present when using telephone modems.

14.C FILE TRANSFER CIPHER?

The question has occurred to the author and others about whether compressed, "binhexed", or plain "modem" file transfers fall under the FCC's prohibition against "ciphers".

The point to begin when considering this issue is, of course, Part 97 of the FCC regulations which governs amateur radio. The specific part is:

> 97.113 (d) No station shall transmit: music; radio-communications or messages for any purpose, or in connection with any activity, that is contrary to federal, state, or local law; messages in code or ciphers where the intent is to obscure the meaning (except where specifically excepted elsewhere in this Part); obscene, indecent, or profane words, language, or meaning; and/or false or deceptive messages or signals.

It should be quite clear that "intent" is a major component of the prohibition. When a file transfer is done, the intent is not to obscure meaning; instead, it is to carry out the most efficient transfer.

Furthermore, just because it may appear as jibberish to someone else, that is not evidence of code or cipher. To someone without a TNC, a packet transmission is undecipherable! Just because somebody else

cannot immediately translate it does not make it a prohibited transmission.

The author wants to thank Mike Curtis (wd6ehr@k6ve .#soca.ca.usa.na) for the insight concerning this issue.

14.D FILE TRANSFER SUMMARY

File transfers can be carried out on packet. It can be done as a text file or using one of the file transfer protocols. Be prepared to experiment.

To many hams, TCP/IP (particularly in the forms of NET & NOS) is just a fancy mailbox. TCP/IP is, or can be, much more than that. This chapter will try to give a wider view of TCP/IP. It is not intended to provide information for setting up a TCP/IP station. See Chapter 19 (Volume 2) for availability of TCP/IP software.

Interest in TCP/IP has been growing steadily among hams. Its popularity is largely due to the develpment of NET and NOS by Phil Karn, KA9Q. Versions are available for many computers including PCs, Amigas, & Macintoshes

15.A WHAT IS TCP/IP?

TCP/IP stands for Terminal Control Protocol/Internet Protocol. While the native environment for AX.25 might be considered radio, the native environment for TCP/IP is Ethernet. This is a cabled network widely used to link computers. In spite of these differences, these two protocols essentially share common lower levels of the layer model (see section 11.B). In radio enviroments, the two differ most obviously in how packets are moved.

TCP/IP is strongly associated with The Internet. The Internet is a system of linked computer networks. Its development was promoted by the U.S. government's National Science Foundation. Initially, it was intended as a network to link research activies at universites and government laboratories. It has since grown to include many companies and is now international in extent. Linking takes place in many ways including microwave, optical fiber, and satellite. The standard data rate is about 10 MB (10 MegaBaud). It is now being pushed to speeds approaching 100 MB. See the Bibliography in Chapter 25 of Volume 2 for printed information about TCP/IP and Internet.

What is normally thought of as TCP/IP is actually a collection of protocols. In addition to the formal IP (Internet Protocol) and TCP (Terminal Control Protocol), there are ARP (Address Resolution

Protocol), FTP (File Transfer Protocol), SMTP (Simple Mail Transfer Protocol), and TELNET (an internet interface allowing non-TCP/IP connections). Many of these will be discussed briefly in this chapter. There are also a number of other protocols which are considered part of TCP/IP but with which hams are less involved.

15.B ADDRESSING

TCP/IP addressing differs quite significantly from that of AX.25. All TCP/IP stations should have a numerical address assigned by an area address coordinator. The address is of the form aa.xx.yy.zz. This address is composed of 4 numbers, each in the range from 0 to 255. When expressed in binary, each number occupies 8 bits; thus, the entire address can be expressed as a 32 bit quantity.

The first number specifies which network the installation is associated with. Hams are assigned to an amateur network designation even though their connection with each other might be through a university or some other network. Our designator is 44 so that all ham IP addresses are of the type 44.xx.yy.zz. The middle two parts of the address are generally associated with a specific physical location. The last part is associated with a specific machine. Actually, if a machine joins several networks, there is a separate address for each connection to that machine.

One of the ways hams express the numerical address is to convert the last three sections to hex. The hex (hexidecimal) number system is base-16 and counts 0,1,2,...,9,A,B,C,D,E,F. The hex number 10 is decimal 16 (1*16+ 0) and the hex number 5A is decimal 90 (5*16 + 10). The first section is ignored because all hams have the same 44. As an example, the author's IP address is 44.26.1.2. The number 26 has the hex value of 1A (1*16 + 10). The number 1 has the hex value of 01. The number 02 has the value 02 (11*16 + 0). In this form, it is expressed as 1A0201 and can be used as a node alias in the AX.25 network.

There is also a name associated with each machine. In the case of hams, all are of the form callsign.AMPR.ORG. Again, in the author's case, it is KA7EHK.AMPR.ORG. This address is called a domain name.

As you come across systems tied into The Internet, you will also see addresses like guille.ece.orst.edu. This computer is part of the edu

(education) network. It is at the location orst (Oregon State University). At that location, it is in (sublocation, department, division, etc) Electrical & Computer Engineering (that is, ece). Finally, the machine is named guille. We will see in discussions about ARP how this domain name is related to numerical addresses.

As an aside, there are only a few highest level domain names. Two have been used above. EDU is used for educational institutions and ORG is used for an organization not otherwise on the list (ie, hams). Other such domain names include COM for commercial organizations, GOV for U.S. government agencies, MIL for U.S. military organizations, and NET for centers involved with internet organization and management. Sites in foreign countries uses a country code in the last position of the domain name.

The next higher levels of the domain name are called subdomains. In the case of amateur domain names, the AMPR denotes something like AMateur Packet Radio.

15.C TCP/IP MESSAGE TRANSPORT

Message transport for TCP/IP uses datagram or connectionless methods previously disussed in Chapter 11.E. Recall that in earlier discussions of AX.25, a link is established between two locations by making a connection. This connection is made when one requests the other to establish a link. When the second acccepts the request and replies to the first, the link is established.

The datagram style is quite different. The sending location simply transmits an Un-numbered Information (UI) packet. It is addressed to the neighbor which the transmitting station believes is capable of delivering the packet. It is then up to the neighbor to do the same until it arrives at the destination.

For this datagram system to be effective, several practical matters must be considered. The primary is that within a particular LAN (in this case, stations on a single frequency), all must be able to hear each other. It is possible to specify digis in routing tables but that, as usual, defeats a lot of the other features.

15.D HOSTS, CLIENTS, SERVERS AND SESSIONS

The concept of a host generally does not mean much to hams unless they have had contact with Internet or similar computer networks. It is a machine which provides servers for users (that is, clients} .

The idea of servers was introduced in Chapter 5. If you read that chapter and some of the following ones, the idea should not be too foreign. If you did not, now is a good time to go back and at least skim that part. TCP/IP uses the idea of servers quite heavily. Some of them are hidden from the user while others (such as telnet) are up front.

A session is the time during which a user interacts with a server. When you ask a callbook server (section 5.D) about a callsign, you initiate a session. In that case, the session continues until the server hands you back to the host. In the case of callbook servers, that happens when the information about the call is delivered to you.

In our AX.25 world, a G8BPQ node can be thought of as a host. It has a variety of servers attached to it. These might include a BBS, a converse server, and a callbook server. There are also the hidden servers which manage connect requests (both local and network). When you activate one of these servers, a session begins and the host is transparent to you. This state of affairs continues until the session ends and you are returned to the host.

In the TCP/IP world, a host is perhaps most easily thought of as a TCP/IP installation. The client might be a user typing at that station's keyboard or it might be another ham who has connected to the station.

While these might just be thought of as fancy names for the things which go on in our network (AX.25 or TCP/IP), the underlying concepts are quite useful. It is also very useful to have well recognized names for these ideas.

15.E TELNET

Telnet is a simple interface between AX.25 packet users and TCP/IP systems. All of the KA9Q programs & derivatives have this package. When you connect to a station using one of these programs and get a prompt line, it usually looks something like this:

```
Area: ka7ehk Current msg# 0.
?,A,B,C,D,E,F,H,I,IH,IP,J,K,L,M,O,P,R,S,T,U,V,W,X,Z >
?
?)help A)rea   B)ye     C)onnect D)wnload E)scape F)inger    H)elp
I)nfo  IH)eard IP)route J)heard  K)ill    L)ist   M)boxusers O)perator P)orts
R)ead  S)end   T)elnet  U)pload  V)erbose W)hat   X)pert     Z)ap
Area: ka7ehk Current msg# 0.
?,A,B,C,D,E,F,H,I,IH,IP,J,K,L,M,O,P,R,S,T,U,V,W,X,Z >
```

As with many mailboxes and BBSs, you get a prompt line on connect. Sending a ? produces the expanded list of commands. From this, it can be seen that the T command initiates a telnet session. When we ask for more information about telnet, the result is generally something like this:

```
?,A,B,C,D,E,F,H,I,IH,IP,J,K,L,M,O,P,R,S,T,U,V,W,X,Z >
H T
     T[elnet] <hostname> [<port_number>]

     The telnet command allows you to initiate a TCP  connection from the
     NOS mailbox out across  the network to another host.  This allows an
     AX.25  user with nothing more than a terminal and TNC to gain access
     to the TCP/IP network.

     By  including  the optional port_number,  you can connect to any TCP
     server at the given  host.  The  default is to  be connected  to the
     "telnet"  server, which  in the case  of NOS  software, is the MBOX.

     To quit the session at any time, enter the escape character (<CTRL>X
     by default, can be changed with the E[scape] command).

Area: ka7ehk Current msg# 0.
```

On the surface, this may seem like so much gibberish, so lets look at what happens in actual use. In the author's area, there are a number of TCP/IP installations. One is an internet gateway and one is a development site for JNOS40 software (see Chapter 25, Volume 2, for more details). The following is an example which begins as a normal AX.25 connection to JNOS40. Then, a telnet session to wg7j.ece.orst.edu. In this case, the result is not particularly interesting because the result is the same as if one did a direct AX.25 connection to IPOSU (the AX.25 node name for wg7j.ece.orst.edu). But what is different is the login/password requirement.

```
cmd: c jnos40
cmd:*** CONNECTED to JNOS40
NOS for the DataEngine.

Type ? for help
t wg7j.ece.orst.edu
JNOS40:WG7J-1}  Trying...  the escape character is: CTRL-T
JNOS40:WG7J-1}  Connected to wg7j.ece.orst.edu:telnet (escape enabled)

KA9Q NOS (wg7j.ECE.ORST.EDU)

Use your callsign as login.
```

```
login: ka7ehk
Password: {
```

Where telnet is the most interesting is internet access. For those who are familiar with the workings of internet, this does not represent any problems. But if you have never used internet, it can be mysterious, indeed. If you need help, section 15.I.

15.F SIMPLE MAIL TRANSFER PROTOCOL (SMTP)

The Simple Mail Transfer Protocol is a procedure for sending mail between TCP/IP stations. SMTP causes mail to be moved in much as it is between AX.25 store-and-forward BBSs. But SMTP generally involves movement between TCP/IP stations (including MSYS BBSs which have TCP/IP capability).

SMTP is a protocol which is used with NOS/NET software. Regular AX.25 users see its effect only when such a message is moved from the TCP/IP world to the AX.25 world. The most obvious difference to users is the message header; it is quite a bit larger than AX.25 BBS messages. This factor has often lead to criticism of TCP/IP as producing BBS mail which is too large.

15.G FILE TRANSFER PROTOCOL (FTP)

The File Transfer Protocol is a method for moving files through a TCP/IP system (including Internet). One may initiate an FTP session and request that a host send a file to you. The host need not be a local one (so long as there is TCP/IP routing to the host). In fact, through Internet, one can have access to files in other computers world-wide. If you are not familiar with the idea of file transfers, see Chapter 14.

It is often through FTP that new versions of NOS are made available.

15.H ADDRESS RESOLUTION PROTOCOL (ARP)

Back in section 15.B, the subject of IP addresses was opened. One of the questions left unanswered in that section was: how do messages get routed to other hosts (that is TCP/IP stations). A second unanswered

question is how addresses get translated between names and numbers. The Address Resolution Protocol is (at least partially) a solution to both questions.

15.H.1 ARP On the Air: Suppose that one TCP/IP station, say 44.26.1.2 (the author, ka7ehk.ampr.org) wants to send a message to 44.26.1.8 (kb7irs.ampr.org). 44.26.1.2 sends a special ARP packet. This packet basically says: what ham station out there has the IP address 44.26.1.8? In this case, it is answered by KB7IRS which says I DO. After this exchange, KA7EHK constructs packets with KB7IRS as the to-call and KA7EHK as the from-call, then sends them as a broadcast or UI packets.

If there was no response, then it is assumed that the specified TCP/IP station is not part of the LAN. LAN, by the way, is an acronym for Local Area Network. Messages to destinations which are not LAN members are directed to a gateway which may be a BBS or a formal gateway into internet.

15.H.2 DOMAIN NAME SERVERS: A key part of address resolution is the domain name server. The domain name server is a device which keeps a list of domain names and associated numerical addresses. It is generally easier for most of us to remember names than numbers. But the TCP/IP system needs the numerical addresses. The domain name server provides translation from domain names to numbers.

It is not necessary that all of the elements of a domain name server be in one location (especially with Internet access). In fact, there is an AMPR.ORG name server at University of California, San Diego (UCSD). If a local name server is queried about an amateur domain name, it is not a local name, and there is Internet access, the UCSD server is queried for the information. You, as a user, will never know as it all happens behind the scenes.

KA9Q software includes a simple name server. In general, this is a simple list which the operator must construct. Sometimes, it is done manually and sometime using lists which are circulated among users. In such lists, the user may attach any name (not just the formal Internet domain name) with a numerical address. For example, I could put in my list the name CALVIN for 44.26.1.8. Whether or not that is that stations correct domain name is irrelevant. It only matters if a network domain name sever must be used.

15.I A LITTLE BIT (MORE) ABOUT INTERNET

Internet provides a dizzying array of services and it seems that the list grows daily. But two of the early services are of particular interest to hams. These are E-mail and News Groups.

E-mail gives one the capability to send messages (that is, mail) to anyone with Internet access. While many hams have heard that this is possible, one of the most frequent questions is HOW? To send or receive E-mail, one needs access to a host which has both Internet access and a mail server. In the author's case, the local BBS is a JNOS installation with Internet access. It accepts both ham store-and-forward hierarchically addressed messages and messages addressed with Internet addresses. As an AX.25 user, one would connect to the BBS and *S name@host* instead of *S callsign@bbs*. The name and host for the destination must be known before the message is deposited on the BBS. The same AX.25 user could tell other Internet users to address mail to the user @ host. In the author's case, the host BBS is WG7J.AMPR.ORG and the complete address would be KA7EHK @ WG7J.AMPR.ORG.

News Groups also include Mail Groups. These are organized around a variety of technical topics including networking, TCP/IP, NOS, etc. The list is very large (about 5000 News Groups & 5000 Mail Groups). News Groups are distributed as bulletins to the whole Internet and are available for reading at many locations. An example of this is rec.ham-radio. Mail is forwarded as a single (sometimes large) message to each participant. One may simply read the messages or may participate in the discussion by sending an e-mail message to the group facilitator. If the message is in comment about someone else's message, that person is often forwarded a copy so that a reply can accompany your message. Your message then becomes part of the next distribution. The easiest way to find out about such News Groups & Mail Groups is to ask at the computer department of your local university.

15.J A WORD ABOUT SOFTWARE

Almost all ham operation with TCP/IP makes use of software originally written by KA9Q. The first try was called NET. It used the computers native operating system. The second version was called NOS and uses a special operating system for PCs which handles the multi-tasking needed for operation of many servers with multiple clients.

Phil Karn, KA9Q, unlike most program writers, has made the original source code of the programs available. He wanted others to be able to build on the core of his work and add the features needed to make it better for users.

NET, because of its use of native operating systems (that is, DOS for PCs) could (with some difficulty and limitation) be translated for other computers. Thus, there are versions for Macintosh and others. But, because of its special operating system, it is likely that NOS will never be available for anything other than a PC.

Because of the availablility of the source code, there have been quite a few versions of NET and NOS. NET-MAC (in several versions) is for Macintoshs. Because of the superiority of NOS, NET is hardly used on PCs any more. The original version of NOS is also rarely used because of the improvments in subsequent versions. The PA0GRI version of NOS is fairly popular and is quite close to the original. JNOS (WG7J) version adds both a good BBS interface for users and much superior node operation. JNOS40 is a version of JNOS for the V40 microprocessor (a super-8086) which is used in the Data Engine. WNOS is a version being developed in Germany. And there are likely at least several more.

15.K MIXING TCP/IP AND AX.25

Until a few years ago, it was widely assumed that AX.25 and TCP/IP would be relatively separate networks. In many areas, this is true. But things have changed significantly with JNOS, TheNet-X, and G8BPQ with IP routing (see Chapter 25, Volume 2).

But mixing of AX.25 and TCP/IP extends beyond this. There is now tunnelling of AX.25 over TCP/IP in which TCP/IP is used as the physical layer (see section 11.C) for AX.25. This system is now in use for BBS forwarding between a number of north American sites using Internet.

It also possible to tunnel TCP/IP over AX.25 to link regions of ham TCP/IP activity when there is no IP routing between the regions.

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DO YOU REALLY WANT TO OPERATE A NODE?

Every now and then packeteers get a strange urge. Why can't I have a node like everyone else does? This chapter attempts to help you answer that question when it arrives for you. We will use the term node to refer to a hilltop site rather than a node associated with a bulletin board.

16.A. DOES THE NETWORK NEED ANOTHER NODE?

There are many reasons why another node might be desirable and as many or more reasons why another node might be a bad idea. Here are some of the network-related issues.

16.A.1 Inadequate access: Perhaps an area (a valley, for example) has poor network access. Maybe retry rates are very high. Perhaps everyone needs to use a digipeater. This is an excellent reason to consider adding a node to a packet network.

16.A.2 Poor network link: Perhaps your local network has a poor quality link. A new node located between the two having the problem could be an excellent addition. But make certain, first, that the problem is not in the nodes, themselves. There could be radio problems, antenna problems, coax problems, or any one of several more problems. Also make certain that the difficulty is not due to an excessive number of other nodes on the same frequency. In this case, just adding another node will make things worse, not better.

16.A.3 Network restructuring: One of the most effective ways to improve a network is to change its structure. If the network is a single-frequency system (users and linking on the same frequency), then convert it to a backbone system (see section 8.D). If the network has a large area backbone, convert it into a clustered system. You can contribute by offering to add a port to an existing node to make either of these happen.

16.A.4 User access: In high population density areas, the number of nodes is especially important. There are some useful guidelines which can help show if there are too few or too many nodes. In the United States, roughly 1 in 2000 of the population has an amateur radio license. Based on TNC sales, it is thought that about 50% of hams own a TNC; this percentage may be optimistic but appears reasonable in some high population areas. Thus, there is about 1 TNC per 4000 population. During peak operating periods (5PM to 8PM local), perhaps 10% to 25% percent of the TNCs may be on simultaneously. Thus, 4 TNCs per 100,000 population (40 TNCs per 1 million population) are active simultaneously. Nodes begin to have problems with 10 simultaneous connections on the same frequency if the channel is perfect (that is, everyone can sense everyone else's transmission); in less perfect conditions, the capacity may be half that. To service the users who would like to operate during peak periods, something on the order of 8 nodes per million population is not unreasonable.

16.A.5 Improve network redundancy: Network redundancy? What's that? In many networks, there are locations where the failure of one node leads to a complete severance of the network without any practical way around the failure (single-point-of-failure). Network redundancy adds parallel paths so that the failure of one does not lead to failure of the network.

16.A.6 Can another node possibly hurt?: Yes! Simply adding one more node to an already overloaded system will make things worse, not better. If the node does not serve a clear purpose, then consider putting your efforts somewhere else.

16.B. WHAT'S THE DOWNSIDE?

Operating a node is much like operating a voice repeater. Here is some of what it involves.

16.B.1 Cost: Nodes do not come cheap. If you were to purchase everything needed, figure on the following for a single port of a TheNet node:

```
TNC           $125
RADIO         $450
ANTENNA       $100
PWR SUPPLY      $50
MISC       $50
---------------------------
TOTAL         $775
```

At severe-weather sites, a durable antenna may actually cost $200 or (much) more.

Site rental is also a major issue. At U.S. government sites in the west (Forest Service, Bureau of Land Management, etc), yearly rents anywhere from $500 to $1000 may be demanded. It is often possible to reduce this figure through certification by your county and state emergency services office. If the site is private, there may be more leeway but expect, at the very least, to pay for a share of electrical costs.

16.B.2 Pressure: If the node fails, you may experience a lot of pressure to get it operating again. This is especially true if the node is a single-point-of-failure or if it is one on which bulletin boards depend. When winter weather makes access difficult, it may be impractical, if not impossible, to meet these demands.

16.C. AND THE PAYOFF?

Of course, along with cost, we expect some sort of payoff for operating a node.

16.C.1 Regional cooperation: A voice repeater often requires community cooperation. With the exception of frequency coordination issues so that repeaters do not interfere or possible linking, the effort remains local. A node, on the other hand, is a regional device. It is part of a network. For this network to operate, it takes cooperation of many individuals and groups. Being part of this cooperative system can be an excellent payoff for some hams.

16.C.2 Public service: A node can be a very significant public service tool. In many areas, county emergency services organizations depend on packet radio for some of their communication. Your node, if it is properly designed and located, can be part of this. Likewise, providing a

highway for bulletin board forwarding or for keyboard-keyboard communication by others represents a public service.

16.C.3 Technological growth: Operating a node is not simple. It requires learning a whole new set of skills. This learning can be a significant incentive for some.

16.C.4 Recognition: If your node provides a genuine service, your efforts will be recognized by users. You may never hear about it. But packeteers will recognize you as a supporter of packet radio who "puts money behind the words you speak". If your node is more of a hindrance than a help, folks will recognize that also. It may take some time, but this too will be recognized.

16.D. A PLEA!

Before you go very far thinking about putting up a node, please talk to node operators in the area you are considering. Courtesy, at the very least, demands it. Ask them a some questions; your efforts will more likely to be well received and effective. Here are some of the things to ask:

16.D.1 Does the idea make sense?: Often, those node operators can tell you if your proposal makes network sense. They can often tell you about areas with difficult access since they have likely heard complaints.

16.D.2 What are the near-term network plans?: Packet networks are undergoing rapid change. In some areas, there are well thought out, written, plans. But this are the exception rather than the rule. More often, a few node operators may have an understanding among themselves about how they want to improve things.

These plans may effect you in two ways. Your effort can help to make the improvements happen. But, also, if you add a node to your local network, you may find changes which will require you to change frequencies, change bands, or change baud rates. If the latter is the case, you should know about it before you start!

16.D.3 What frequencies are available?: The question affects both user frequencies and linking frequencies. If the question is one of a user frequency, the node ops may be able to suggest something themselves.

If there is a frequency coordinating group in your area, they should be able to tell you how to reach it.

With respect to linking frequencies, which one is appropriate? Often, that tantalizing link with only two nodes on it is designed that way as a point-point link (see section 8.D). In other cases, your proposal may appear as a hidden node to some of the other nodes on the backbone. In yet other cases, there may already be too many nodes on one frequency. The best backbone frequency for your node may not be obvious, so ask.

16.D.4 Is your proposal welcome?: In some areas of the U.S., groups have a very strong hold on network linking. They often attempt to control very tightly what nodes are a part of that network. If such is the case in your area, and your efforts are rebuffed, you might check to see whether or not there are other organizations which also organize networks or if there are networks which the group does not control. If you fail on all counts, you might try some other hobby!

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DO YOU REALLY WANT TO OPERATE A BBS?

There is another urge which often strikes packeteers. It is the BBS-urge. There are many parts of this issue which also involve node operation. If the BBS urge has hit you, please read Chapter 16, also. If this chapter looks like Chapter 16, it is because the questions are so similar.

17.A. DOES THE NETWORK NEED ANOTHER BBS?

There are many reasons why another BBS might be desirable and as many or more reasons why another BBS might be a bad idea. Here are some of the network-related issues.

17.A.1 Inadequate access: Perhaps a hilltop node has no BBS associated with it. The users of this node must then traverse the network to use another. Every message read must cross the network once for every reader. If there is a local BBS, the message travels across the network once, or perhaps twice (if the BBS forwards messages on somewhere else). If there are a sizable number of BBS users on a node, the network will actually be more lightly loaded through the addition of a BBS.

17.A.2 User access: In high population-density areas, user access to a BBS is as important as it is to a node. A BBS tends to slow significantly when there are more than 3 or 4 simultaneous users. The same arguments used in section 16.A.4 would then suggest perhaps a minimum of 4 bulletin boards per million population if 50% of the peak-time users try to access a BBS.

17.A.3 Improve forwarding redundancy: Forwarding redundancy? It is the same idea as network redundancy. If one BBS is heavily relied on to forward between two parts of the network and it fails (as it will, sooner or later), an alternate BBS can fill in. This is somewhat less important an issue, however, than the single-point-of-failure in a

network. In this case, the messages can still travel between bulletin boards, even though they are separated by more nodes than normal.

17.A.4 Can another BBS possibly hurt?: Yes! There are examples far and wide of a second BBS added to a hilltop node to relieve congestion. But when the node links to the BBSs on the same frequency as the one used by regular users, the problem is worse, not better.

17.B. WHAT'S THE DOWNSIDE?

Operating a BBS is much like operating a node. But there is more.

17.B.1 Cost: BBSs do not come cheap. If you were to go out and purchase everything needed, figure on the following for a single port BBS:

TNC	$125
RADIO	$450
ANTENNA	$100
PWR SUPPLY	$50
MISC	$50
COMPUTER	$800
TOTAL	$1575

The estimated computer cost will probably purchase you a used monochrome machine with a small hard-drive. Do not plan on using your regular computer simultaneously as a BBS and for other home uses. It is more trouble than it is worth and mistakes while running other programs can be detrimental to BBS operation. Be also aware that almost all BBS programs are for DOS machines; there does not yet seem to be a real Macintosh or Amiga BBS program.

17.B.2 Pressure: If the BBS fails, you may experience a lot of pressure to get it operating again. This is especially true if there are many users or it is associated with emergency services operations. Failures will come. The computer seems to be the most failure-prone part and the hard-drive the most failure-prone part of the computer. Backup, backup, backup!

17.C. AND THE PAYOFF?

Of course, along with cost, we expect some sort of payoff for operating a BBS.

17.C.1 Regional cooperation: Operating a BBS means sharing forwarded messages with neighboring BBSs. This takes cooperation. It also means that you should become part of this cooperative process. Doing so means that you should be able to reach consensus with others and learn how to disagree without being disagreeable!

17.C.2 Public service: A BBS can be a very significant public service tool. In many areas, county emergency services organizations depend on packet radio for some of their communication. Handling NTS traffic is beneficial, also.

17.C.3 Technological growth: Operating a BBS is not simple. It requires learning a whole new set of skills. This learning can be a significant incentive for some.

17.C.4 Recognition: If your BBS provides a genuine service, your efforts will be recognized by users. You may never hear about it. But packeteers will recognize you as a supporter of packet radio who "puts money behind the words you speak".

If your BBS is more of a hindrance than a help, folks will recognize that also. It may take some time, but this too will be recognized.

17.D. A PLEA!

Before you go very far thinking about putting up a BBS, please talk to BBS operators in the area you are considering. Courtesy, at the very least, demands it. Ask them a some questions; your efforts will more likely to be well received and effective. Here are some of the things to ask:

17.D.1 Does the idea make sense?: Often, those BBS operators can tell you if your proposal makes network sense. They can often tell you about areas with difficult access since they have likely heard complaints.

17.D.2 What are the near-term network plans?: Packet networks are undergoing rapid change. BBS forwarding is greatly effected by the organization of the network on which it relies.

Perhaps the operator of local hilltop node would like hilltop-BBS linking on a separate frequency from users. This generally improves BBS (and node) operation substantially. When this change is made, forwarding in and out of the BBS are not seen as traffic by users. It may mean that a radio you had planned to use is no longer appropriate. Similarly, planned changes in radio baud rate can effect your modem needs.

17.D.3 What frequencies are available?: The question affects both user frequencies and linking frequencies. Some bulletin boards have more than one port. If there is going to be a separate user's frequency, what frequency should be used may be an issue.

If the BBS is going to link on a backbone frequency, which backbone is appropriate may also be an issue.

17.D.4 Is your proposal welcome?: In some areas of the U.S., there are BBS wars. Neighboring bulletin boards to not forward to each other. There are arguments about the types of messages to be forwarded (or more usually, not forwarded). There are complaints about how bad a BBS is for the network.

Some node owners do not welcome a BBS. Find out before you invest!

As mentioned in the introduction, amateur packet is a very fluid area. Some of what we have today could be seen a few years ago and some could not. This is written from the perspective of mid-1993. What is discussed in this chapter are some of the developments which seem very near at hand or toward which current trends point fairly strongly. There will certainly be some hits and some misses. But these topics should help to keep some currency to the book for a little while!

18.A. HIGHER SPEEDS

What's the big deal about higher baud rates? Isn't 1200 baud good enough? The same might have been said about 45mph Ford Model-T's. Now, much of the "high" baud-rate activity is on backbone links but there are areas of the U.S. where users operate at 9600 baud or higher.

18.A.1 WHY HIGHER BAUD RATES? The reasons is pretty simple. Our frequencies are limited; higher baud rates let more packets flow on the same set of frequencies. A less obvious reason is that each station occupies a given frequency for a smaller time interval (given the same number of characters); thus, more stations can be accommodated. A third reason has to do with usability. As baud rates increase, servers running on distant nodes seem to you as if they are local. Thus, it is possible to distribute the "power" around a network; then there is less pressure for call-book servers, converse servers, etc to be available at everybody's node.

18.A.2 WHY DOES EVERYONE USE 1200 BAUD? First, everyone doesn't use 1200 baud (even discounting the lower baud rates used on H.F.)! But, still, why do most packet users use only 1200 baud? The reason is pretty simple. Until quite recently, hardware (that is, TNCs) running faster than 1200 baud were fairly scarce.

The standard TNC2s have built-in to them a modem disconnect header. This is a place where a non-1200 baud modem can be installed. Almost

as long as there have been TNC2s, there have also been 2400 baud plug-in modems. Unfortunately, the number of 2400 baud users have never reached a critical mass required to generate corresponding support from node owners; a 2400 baud signal won't work on a 1200 baud node! Also, the plug-in modems cost nearly half as much as the TNC, itself. Many felt that the added expense was not worth the rather minimal improvement. But 2400 baud has one advantage; it can be used on radios just like 1200 baud; both are AFSK (see section 1.A). One of the additional difficulties is that once a TNC has been modified for a baud rate other than 1200, it is difficult to switch it back.

Several packet modems are now available for use at 9600 baud or 19.2Kbaud. Plug in modems for these baud rates are also available for TNC2s.

For higher baud rates, true FSK (also see section 1.A) is generally used. This creates a problem with radios. With FSK, one cannot simply take audio from a loud-speaker jack and put audio into a microphone jack. The modulation is different and few radios accommodate this without modification.

18.A.2 BAUD RATE AND MODULATION: One of the factors governing baud rate is bandwidth. Amateur transmissions are limited in their bandwidth. Within the 6 meter (50-54MHz), 2 meter (144-148MHz) and 1.25 meter (222-225 MHz), we are limited to 20KHz bandwidth. At frequencies above 420MHz, wider bandwidths are allowed.

Bandwidth is the spread of frequencies occupied by a signal. The bandwidth of an unmodulated signal is nearly 0. The term nearly is used because there is no such thing as an absolutely pure signal; even the best there is at the present (Cesium frequency standard) is not absolutely pure. The bandwidth occupied by a signal and its modulation depends on the type of modulation and the information which the modulation carries. That is, SSB has different bandwidth than FM for the same type of information. In our case, the information is digital. And, generally, the MINIMUM FM bandwidth needed is about twice the baud rate. Thus, 9600 baud needs at least 19.2KHz bandwidth. Thus, with the proper modulation techniques, 9600 baud could be legally used on 2 meters!

At 2400 baud and slower, AFSK (that is 2-tone) modulation of FM transmitters is normally used on VHF. At 9600 baud, switching between

two tones becomes impractical because of the short time spent on any one tone; there are too few cycles of the tone to accurately tell which is which. Thus, direct frequency shift keying is used.

There are a few packet-ready radios which modulate and demodulate FSK signals. At the present time, they are fairly expensive and a bit tricky to operate. Other transceivers can be used but require modification. Unfortunately, this step is one which many hams are reluctant to carry out.

18.A.3 EVEN HIGHER BAUD RATES: Up to this point, it may have appeared that 19.2Kbaud is about as fast as anyone is thinking about. That is not so. 56Kbaud systems are in use in several parts of the U.S. Because almost everything is home-brew at these rates, it has tended to be experimental or for point-point links. At microwave frequencies (1200MHz or 1.2GHz and up), baud rates of 10,000Kbaud (10Mbaud) or higher are being developed.

18.A.4 WHAT ARE THE PROBLEMS WITH HIGHER BAUD RATES? In addition to the lack of equipment, there are some real technical problems at rates of 9600 baud and above. Multi-path (see section 3.E.1) becomes more significant at higher baud rates. The effect increases as baud rate increases. As bandwidth requirements exceed that of normal voice communication, the filtering within transmitters and receivers must change. Thus, for rates above 9600 baud, radios must almost be constructed specifically for the application.

18.A.5 OTHER TRANSMITTER CHARACTERISTICS: In addition to the characteristics previously mentioned, one of the transmitter characteristics which severely limits the usefulness of higher baud rates is called t/r switching time. This problem was alluded to in section 6.G in discussions about BBS loading of the packet network.

Suppose we take an ordinary transceiver which might take 300mS to stabilize after switching from receive to transmit. Suppose we take a 125 character packet with an overhead of another 50 characters (about 25 actual header characters and more for network management). These 175 characters take 140mS at 1200 baud and 18mS at 9600 baud. The total transmit time is the sum of the stabilization time at the beginning of the transmission and the time needed to send the packet. Thus our average transceiver would take 300+140 or 440mS at 1200 baud; at 9600 baud, it would be 300+18 or 318mS. Obviously, in this case, higher baud rate gains rather little. Even at a stabilization time of 100mS,

the transmit time only changes from 240mS to 118mS. Note that even in this case, an 8 times increase in the baud rate has only halved the time the transmitter is on.

The consequence of this factor is that transceivers with t/r switching times under 25mS (preferably even less) are needed to see the full benefit of higher baud rates. Attempting to use old transceivers with slow t/r switching at high baud rates is thus an illusion with very little benefit for the cost of high speed TNCs.

18.B. MICROWAVE

Microwave is one of the big frontiers for amateur radio and packet is no exception. Microwave permits wider bandwidths and higher baud rates. We are already seeing conversion of surplus military and telephone microwave to amateur use. It seems likely that, with this equipment available, we will see very high bandwidth amateur microwave links which carry multiplexed (that is, shared) voice and data. Thus, there might very well be repeater-repeater voice linking and node-node packet links on the same microwave signal.

Microwave has the advantage of very narrow antenna patterns. Thus, the frequencies can be shared over closer distances than with lower frequency signals. This should particularly attractive in congested metropolitan areas.

Microwave signals do tend to be effected more significantly by atmospheric changes. Certain weather conditions even cause loss of commercial microwave paths at times. Microwaves tend to be reflected more easily. This can be both an advantage and a disadvantage. Multi-path is one of the negative effects. Passive reflectors to bend paths on purpose are a positive effect.

18.C. FULL DUPLEX OPERATION

Full duplex operation is like a voice repeater. NODE1 transmits on frequency A and receives on frequency B. NODE2 transmits on frequency B and receives on frequency A. Packets can be passed both ways simultaneously. No waiting is required. There are no collisions between the neighbors. All-over character rate can be more than

doubled (especially if real data is flowing both ways).

The problem is that full-duplex requires twice the bandwidth. On microwave bands, in particular, there appears to be bandwidth to make this practical.

Full-duplex is also possible on user frequencies. Most TNCs support either simplex or duplex operation . Duplex nodes are constructed more like voice repeaters than like traditional nodes.

18.D. NETWORK STRUCTURE

The preceding sections of this chapter and the discussion of networking in Chapter 8 both suggest that there are some changes in network architecture in the works. Especially in high traffic-density areas, the move toward point-point networking is already underway. In all fairness, however, it should be pointed out the much of our network will never be point-point. Many locations do not have the economic resources or frequency availability.

Once point-point linking is common, there will, in all probability, be less reluctance to go higher in baud rate, full duplex, and microwave. This is because each link is the responsibility of only two node-ops; that link no longer has to be operated cooperatively with other nodes so long as it has the through-put. That is, it no longer makes any difference what frequency, baud rate, or other technical characteristics a specific link uses. So long as packets can move through, the rest of the network will be happy! And so will the users be happy!

18.E. IP ROUTING

With the advent of TheNet-X (see Chapter 25 in Volume 2) and the spread of TCP/IP installations (particularly JNOS), it is not hard to forecast the growth of IP routing. While it had often been thought that AX.25 (see Chapters 1 & 11) and TCP/IP could not or would not coexist peaceably, there is now plenty of evidence that they will.

It does appear true that there will be IP-only networks because there are quite a few in operation right now. Mixed networks will bring TCP/IP to more users, however, without having to duplicate facilities. This will certainly lead to a more rapid growth of amateur TCP/IP.

18.F. OTHER FUTURES

There are other futures which are a lot less encouraging than those outlined above. Areas of the east coast in high population density areas are suffering now from lack of aggressive network improvement. As more and more users attempt to operate in this system, it is more-or-less rapidly grinding into a state of near-uselessness. Over-loaded frequencies, poor network architecture, & lack of investment in network facilities have all contributed. Unfortunately, this situation does not attract those who are capable of solving the problem!

It is the author's sincere hope that this book may, in some way, encourage the continued improvement of our packet system. And where it seems blackest, those of good will should not give up. Find out how folks in other areas have solved problems similar to yours (and almost always, somebody has!) Then go to it!